2012

Clovis Blade Technology at the Topper Site (38AL23): Assessing Lithic Attribute Variation and Regional Patterns of Technological Organization

Douglas A. Sain

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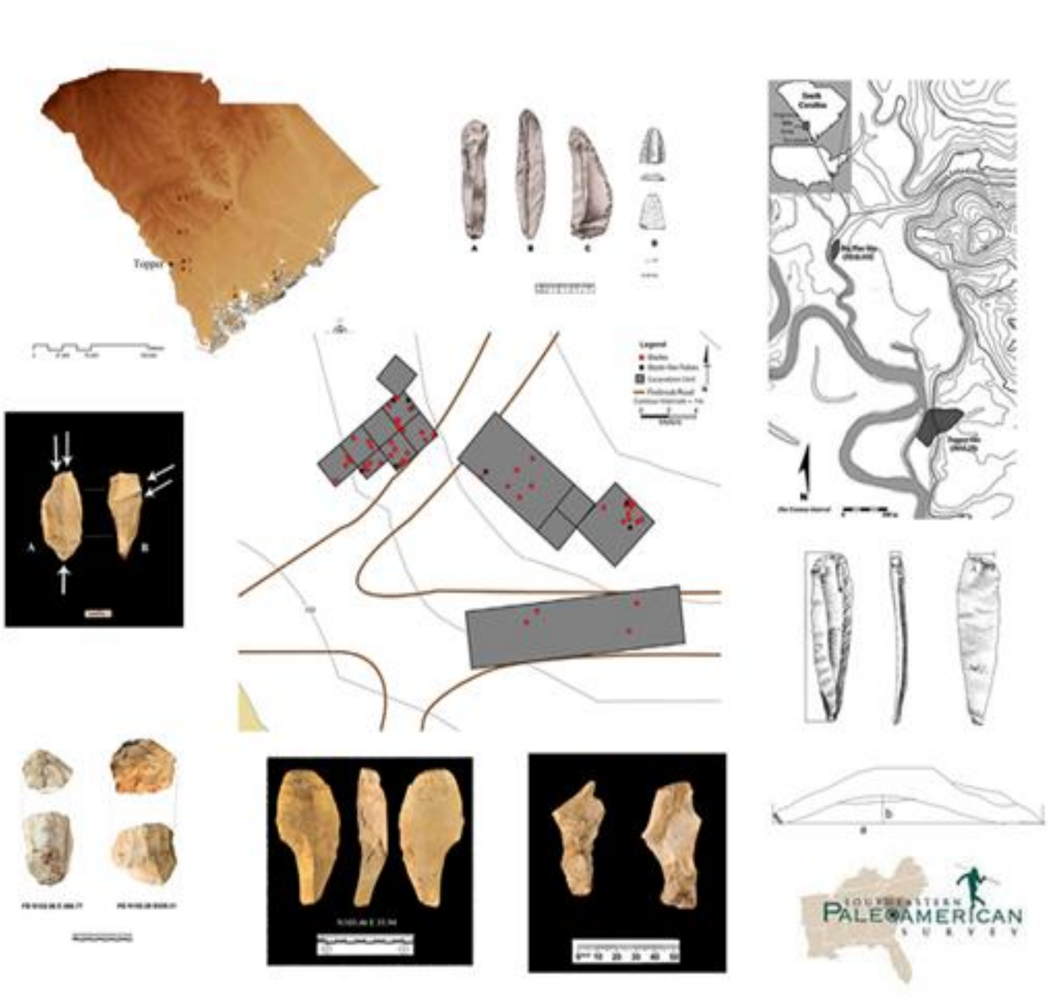

Occasional Papers 2 **2012**
Southeastern Paleoamerican Survey
South Carolina Institute of Archaeology and Anthropology
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David G. Anderson, Ph.D., RPA
Professor, Department of Anthropology
The University of Tennessee
250 South Stadium Hall
Knoxville, Tennessee 37996-0720
dander19@utk.edu <dander19@utk.edu>

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Foreword

It is a pleasure to introduce this monograph by Douglas A. Sain, which is based on his master's thesis research on the organization of Clovis blade technology. This second monograph of the Occasional Papers series of the Southeastern Paleoamerican Survey closely follows the first in terms of the meticulousness of the study, and the new information it provides about the Topper Site. Detailed studies of Clovis material are eagerly sought by Paleoindian archaeologists, enthusiasts, and particularly by lithic analysts. Sain provides a well-rounded literature review for these groups, and an innovative approach to identifying technological blades. The "mixed assemblage" problem resulting when multiple lithic technologies were used at a single site is one with which lithic analysts continue to struggle. With a quarry site such as Topper and the wide variety of core forms and tools recovered, a nuanced and consistent approach to blade identification is a necessity if one wants to consider broader questions of technological organization. Recognizing variability in the end-product of blade manufacture and the relative importance of some characteristics over others, Sain weights six attributes from three to one and through detailed study of individual detached pieces produces a score. With a maximum value of 12, those with a score of seven or higher are considered a blade. This provides a consistent, replicable procedure for separating blades from blade-like flakes, and using these data in the consideration of Clovis lifeways. The small percentage of blades at Topper with modification, when coupled with a consideration of assemblages in the local and broader region, provide evidence that blades were part of a curated technology and toolkit, a transportable and reliable product that could be maintained as people moved across the landscape. This work provides a specific reconstruction of Clovis technological organization in the Savannah River Valley, and should inspire broader considerations of blade technology elsewhere in the Americas.

Philip J. Carr, Professor
Department of Sociology, Anthropology, & Social Work
University of South Alabama

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Chapter I

Introduction

One of the most intriguing components of the Clovis lithic toolkit is the technological blade. A blade is an elongated flake with parallel margins, and two or more unidirectional removal scars on its exterior surface. While biface and flake tools are common artifact forms recovered at a number of Clovis dated sites, blades are not typical of Clovis assemblages in all regions. However, blades and evidence of their manufacture are often observed in context with the products of other stone tool production approaches, and flakes appearing as blades may be misidentified as belonging to a standardized blade technology. As a result, it becomes important to differentiate blade-like flakes and other flakes from those artifacts that are a product of technological blade manufacture.

This research is a technological examination of the blade and blade-like-flake assemblage recovered from the Topper site (38AL23), a multi-component Clovis site located in Allendale County, South Carolina. Topper has been identified as a quarry/manufacture site where a variety of stone tools were produced (Goodyear et al. 2007). Consequently, debitage associated with multiple approaches of lithic tool manufacture may be present among the assemblage. Topper has produced a dense and varied assemblage in the form of bifaces, preforms, blades, cores, and debitage, which in turn include curated as well as expedient lithic technologies. The primary goals of this research are to determine the technological approach or approaches used to produce Clovis blades at Topper, to establish the sequences involved in blade production, and to acquire a broader understanding of the role of blades in the organization of Clovis lithic technology in this part of the southeastern United States.

Despite much research on Clovis lithic technology, relatively few analyses have emphasized the role of blades, much less how blade production fits into broader issues of technological organization. In the Southeast, recent Clovis research has been geared toward locating and identifying distributions of fluted bifaces and projectile points (Anderson and Faught 2000; Anderson et al. 2010; Morrow and Morrow 1999), while few studies have provided insight into the role of Clovis blades and blade technology in similar context. Often, reports only mention the presence or absence of blades at Clovis sites, offering morphological descriptions of attributes common among these assemblages. Few reports however provide criteria as to the specific technological traits that set them apart from other flake reduction approaches or how they may compare to other Clovis blade assemblages within the region.

The systematic analysis of blades is not yet widespread, but more comprehensive studies are related to assemblages from the Plains and Mid-South (Collins 1999). It is important to evaluate blade production across regions to document the presence of homogeneity or variation that might exist across space. Such studies can provide information on manufacture technique, raw material utilization, and technological organization. Necessary to such studies is an objective method for identifying and describing Clovis blade technologies. The possibility that variation exists in methods employed in Clovis blade production is a warrant for such an analysis. As such, a comparison of the blade attributes at Topper to those from assemblages in other regions is undertaken.

The structure of this research is organized around two objectives. The first is to establish the technique(s) employed in blade production at Topper. Characteristics of different lithic manufacture techniques are discussed, which subsequently may then be used to form inferences about what kind of attributes we should expect given a specific technique. The second objective is to obtain a broader understanding of the role of Clovis blade production within the central Savannah River Valley of South Carolina, and what Goodyear et al. (1990) refer to as the Allendale Brier Creek Clovis Complex. A technological examination of the blades, cores, and blade production debitage at Topper enables conclusions to be formed regarding the nature, degree, and intensity of blade production at the site. Furthermore, such an in-depth analysis can provide valuable information regarding stone tool production, use, and discard at quarry-related sites in this part of the Southeast. Subsequent comparisons can be made to other blade assemblages and /or isolated finds from the region, and may allow inferences to be formed regarding the organization of Clovis technology. For example, from the character and distribution of blades and cores we can better understand the role these artifacts served. Moreover, variation in blade attributes at Topper, when compared to blades from off-site contexts, if present, may inform us about the types of blades most often selected for use by Clovis inhabitants of the region. Such patterns are integral to assessing Clovis adaptation in the Savannah River Valley of the southeastern United States (Goodyear et al. 1990).

This monograph is organized into seven chapters and three appendices. Chapter introduces the research problem and provides a framework for analysis. Chapter I is followed by three background chapters. Chapter II provides a description of the Clovis culture complex. Here, a synthesis of the current debates on aspects of Clovis origins, sites, subsistence, lithic production, and technological organization is offered. Chapter III provides an overview of Clovis Blade technology, and a summary of the history of blade research with emphasis given to the southeastern United States. Here, an in-depth discussion on the steps involved in Clovis blade production is provided. Particular attention is given to aspects of core preparation, successful blade detachment, and subsequent core rejuvenation. Chapter IV is a description of the site setting. In addition, a brief description of the excavation history and lithic assemblage at the Topper site is given. In Chapter V, the analytical methods are provided, followed by the results of analysis in Chapter VI. Chapter VII provides an interpretation of results of analysis, followed by conclusions and directions for future research in Chapter VIII. Finally a series of appendixes are provided following the conclusions. Here, data discussed in the text is presented in table format.

Problem Orientation

The fundamental goal of this research is to identify and describe the blade technology at the Topper Site. Are the artifacts identified as blades at Topper the result of a formalized reductive approach, with a goal to produce blades, or are such artifacts a product of other approaches of lithic tool manufacture. Data taken from a sample of 472 artifacts recovered from the Topper site are used to ascertain if a true Clovis blade technology exists there, or if those artifacts previously identified as blades are in fact blade-like flakes that can be a product of multiple reduction approaches. Of particular concern is the reductive approach employed at the site. Studies have shown that Clovis lithic production is not limited to a single "reductive" task, but may be incorporated among other approaches and may include

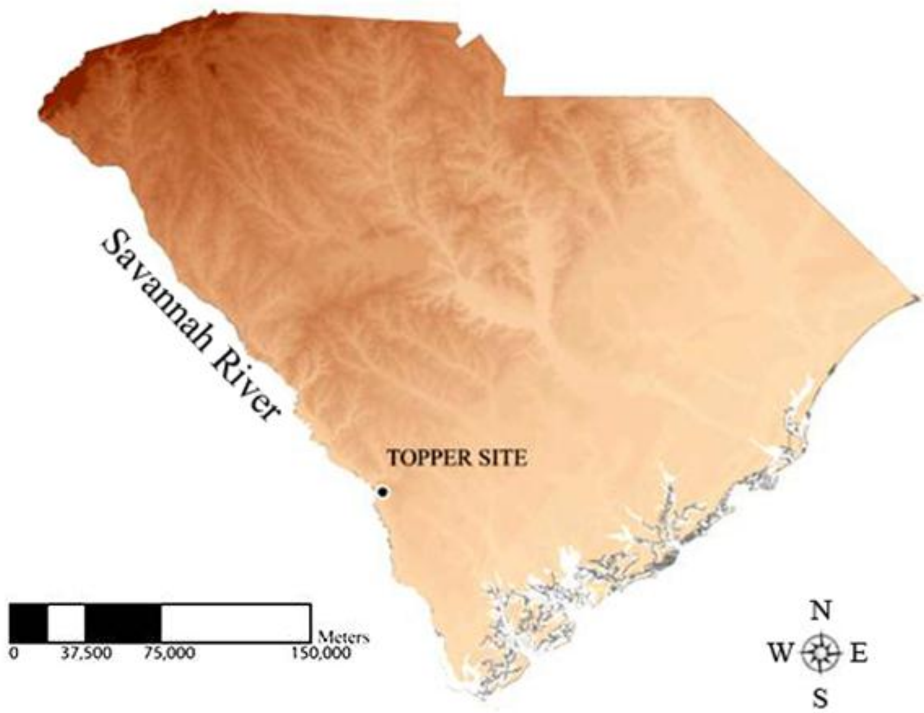


Figure 1. Map of South Carolina with the location of the Topper Site (38AL23) highlighted.

"end thinning, fluting, and initial blank production" (Dickens 2005:11). The Topper site (Figures 1 to 3) is identified as a quarry and quarry-related lithic manufacturing site where initial reduction activities took place, and where Clovis blade and biface manufacture "appear to be closely linked at the stage of initial reduction" (Goodyear et al. 2007; Collins and Lohse 2004:177). Flakes that exhibit the morphological characteristics of blades may be produced as a result of bifacial manufacture, and may be misidentified as having been produced through blade production.

In this study, I attempt to distinguish blades, the product of a specific technology, from blade-like flakes, artifacts that may fit the morphological definition of a blade, by examining specific technological attributes of each artifact. By morphological definition I refer to any flake whose dimensions are twice as long as its width. An analysis that focuses upon technology, or how the artifact is produced and the behavior(s) inherent in such production, is necessary to discriminate between different lithic reduction approaches. To identify a specific technology requires evidence not only of particular blade attributes, but attributes of the associated cores and debitage as well. Therefore, this analysis incorporates multiple lines of evidence. These analyses emphasize a suite of attributes, and focus on those that define technology as a specific, purposeful behavior, as opposed to strictly morphologic variables that may result from simple convergences. Moreover, attributes are chosen not for their descriptive value, but

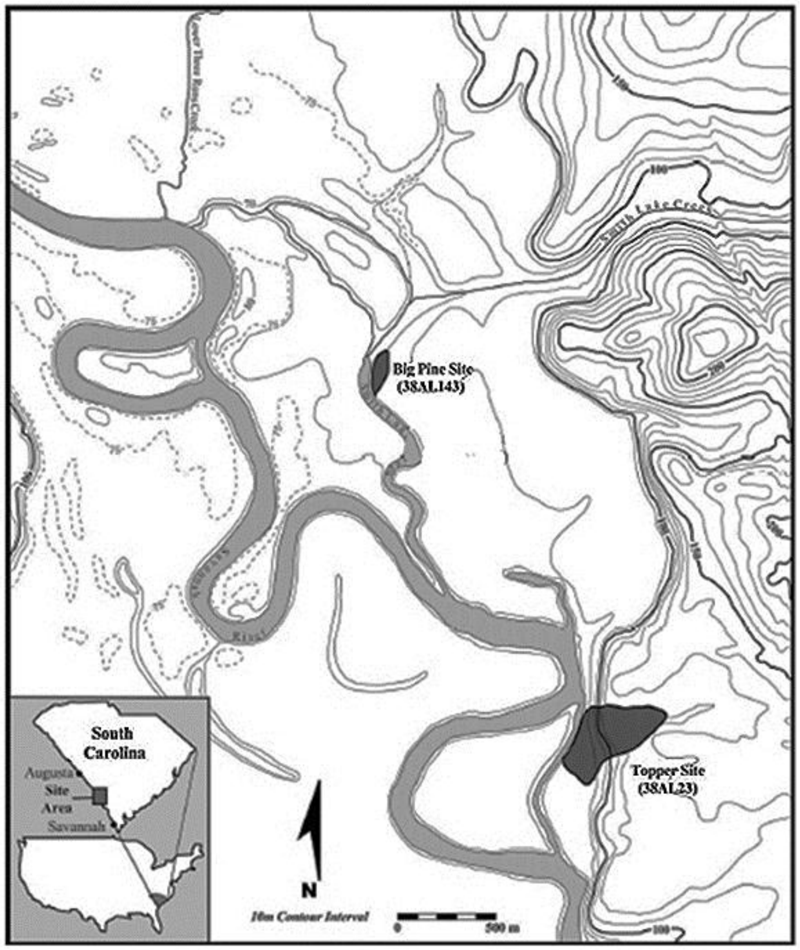


Figure 2. Location of Topper Site in relation to lithic manufacture Sites in the Savannah River Valley. (Adapted from Waters et. al 2009).

for what we can learn of them by first documenting the conditions we may expect given certain technological variables. From this point forward, the term blade is used in reference to technological blade production. I refer to those artifacts that may be a product of other approaches of lithic tool production as blade-like flakes, or that simply fit the morphological definition of a blade. If a blade technology exists at Topper, a second objective of this research is to describe the approach or approaches involved in blade production at the site. The extent and quantity to which blade production was carried out at Topper is of importance. For example, the degree to which formalized blade cores were reduced onsite may provide important information relating to issues of technological organization and lithic processing in the Savannah River Valley. According to Robert Kelly (1988), lithic technological organization is defined as the relationship(s) between the spatio-temporal placement of

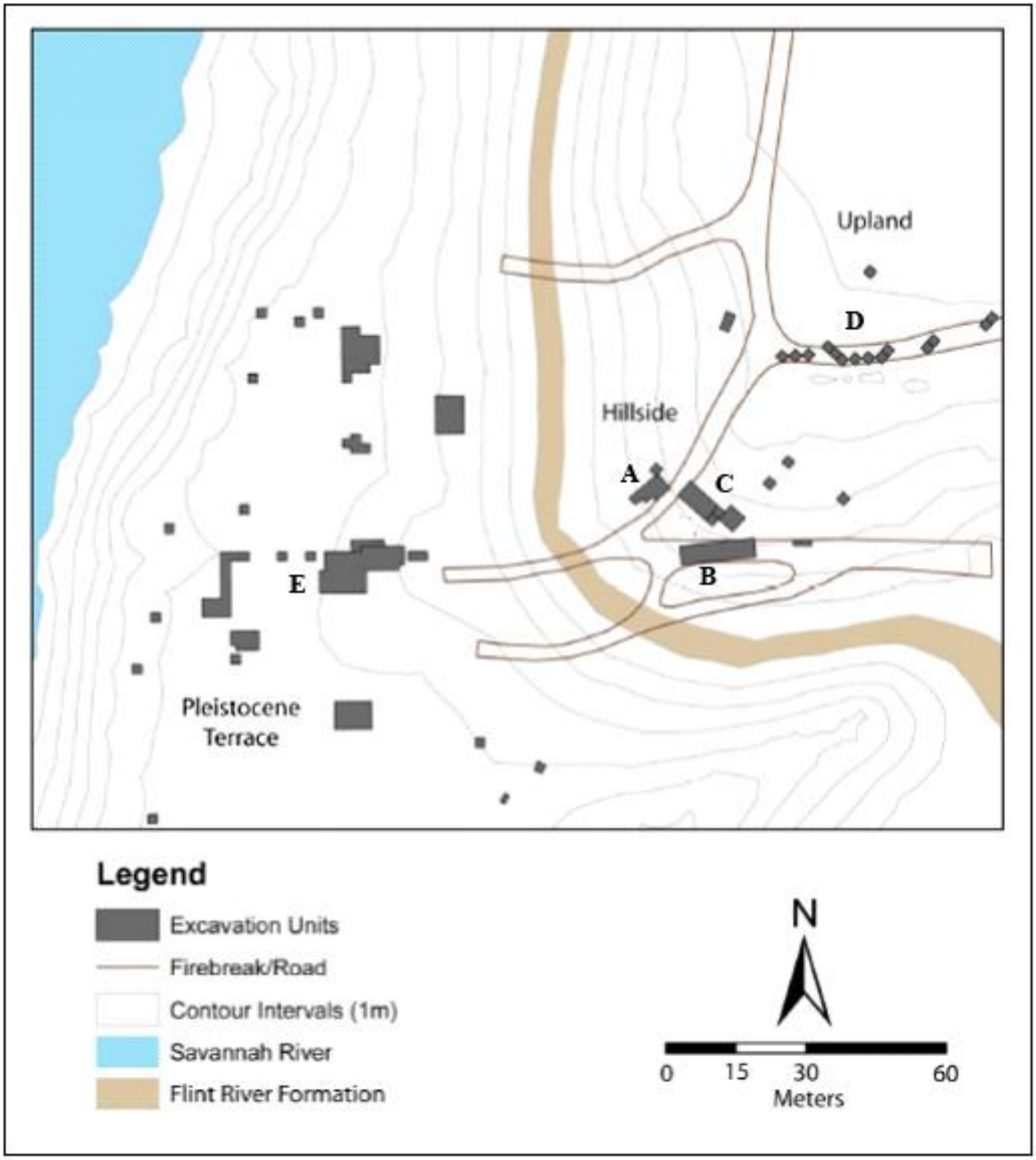


Figure 3. Excavation map of the Topper Site from 1984-2008 (38AL23). Letters represent excavation blocks discussed in the text. (Adapted from Chandler 2006 and Miller 2007, 2010).

the "manufacture of different tools within a system", not only to aspects of their "use, reuse and discard, but to tool function, raw material properties and behavioral variables which mediate the spatial and temporal relations among activity, manufacturing, and raw material loci" (Kelly 1988:717). To this end, I offer three testable models that can assess lithic reduction approaches as they relate to technological organization.

Model 1: Blades are the intended final product of the reduction approach, produced in response to specific tool needs, and intended for use at Topper. If blades were produced at Topper for specific tool needs, then there should exist evidence of their use in the form of modification that implies their purpose for onsite use at the site.

Model 2: Complete blades were transported away from Topper for offsite activities, leaving behind the broken and discarded specimens that do not fit onsite needs. The transportation of blades offsite implies that such artifacts were an integral component of the lithic toolkit abroad, and one should expect a greater abundance of modified or utilized blades in such regions compared to quarry related sites.

Model 3: Raw material extracted onsite is reduced for the purpose of core production, whereby "roughed out" cores served as blanks for the future production of tools elsewhere. This model implies that the onsite production of prepared cores would have occurred in anticipation of future circumstances, and that such cores would have been reduced as needed, rather than in response to specific and immediate onsite tool needs. This model further implies that the onsite production of prepared cores at quarry and quarry related sites should not be highly reduced or exhausted.

Blades technologically comparable to Clovis have been recovered from private surface collections in the central Savannah River Valley. These blades are usually reported as isolated finds, with little other information in comparison to existing lithic assemblages. These blades frequently exhibit evidence of unifacial retouch, modification, or use along their margins (Steffy and Goodyear 2006). Furthermore, they appear to be produced from Allendale chert, the same chert type that is found at Topper and other nearby quarry related sites (Goodyear and Charles 1984). The heavy reliance upon high quality lithic material during the Clovis period (Goodyear 1979, 1989) suggests a significant link between the central Savannah River Valley where numerous chert quarries have been documented, and areas where isolated blades have been reported. As such, this research considers the relationships between blade production, use, and patterns of lithic technological organization and subsistence in the Southeast. To determine the role of blade production at Topper, and how it relates to broader aspects of technological organization in the region is a second goal of this research.

Chapter II

THE CLOVIS CULTURE

The Clovis culture is long considered by many to be the oldest well-documented culture complex to inhabit North America (Bonnichsen and Turnmire 1991; Haynes 1964, 1969). Clovis hunters are proposed to have "followed" the distribution of megafauna into North America, rapidly populating the continent, extending as far as the tip of South America within a millennium (Fiedel 2000; Haynes 1969, 1980, 1982; Martin 1973). Archaeological evidence in the form of fluted projectile points (Figure 4) recovered in context associated with the butchered remains of extinct megafauna, form the basis of claims that Clovis specialized in the hunting of large game. Some studies hypothesize that an earlier, pre-Clovis population may have been the first to inhabit the new world, preceding that of Clovis (Bradley and Stanford 2000; Stanford and Bradley 2002; McAvoy 1997; Dillehay 1997).

One of the earliest documentations of a Pleistocene human presence in the new world comes from the 12 Mile Creek site in Kansas excavated during the summer of 1895 where a fluted projectile point was recovered in context with the remains of extinct bison skeletons (Hill 2006). At the time, this discovery went largely overlooked. Widespread acknowledgement of an early human presence only occurred with the 1927 discovery of fluted projectile points associated with *Bison antiquus*, an extinct form of Bison, at Folsom New Mexico (Figgins 1927). Clovis was first identified at the Dent site in Colorado in 1932, though the projectile points recovered were assumed to represent Folsom derivatives (Haynes and Huckell 2007). As a cultural complex, Clovis was first identified at the Blackwater Draw site near Clovis New Mexico in 1937 (Hester 1972:26). Here, fluted projectile points were found associated with the disarticulated remains of mammoth and other extinct Pleistocene age animals. The presence of such artifacts in strata below that of Folsom preclude the notion that they were simply derivatives, and implied that an older culture occupied the region prior to Folsom. Moreover, the discovery of a blade cache at the site (Green 1963) suggests a dependence on other artifact forms apart from projectile points. The raw material from which these tools were produced was not local to the surrounding region, supporting evidence that Clovis hunters must have sought exotic raw materials, and incorporated a mobile, highly adaptive way of life.

Since the discovery at Blackwater Draw, Clovis sites have been identified throughout most of North America (Figure 5), and artifacts attributed to the Clovis culture have been recovered from Mexico and documented as far south as Venezuela (Pearson 2004; Waters and Stafford 2007). Occupying much of North America by the terminal Pleistocene, dates obtained for Clovis sites range from as early as 11,500 RYBP (Aubrey, TX) to as late as 10,800 RCYBP (Jake Bluff, OK) (Ferring 2001; Waters and Stafford 2007). A recent analysis (Waters and Stafford 2007) of radiocarbon dates taken from a sample of well-dated sites suggests however, that Clovis, as a cultural complex, may have endured for as little as 250 years (ca. 11,050 to 10,800 14C yr B.P.). According to this model, Waters and Stafford propose that Clovis technology was "quickly adopted by preexisting populations" responsible for the short duration as visible in the radiocarbon record. Haynes and Huckell (2007) recommend the need for additional dating of

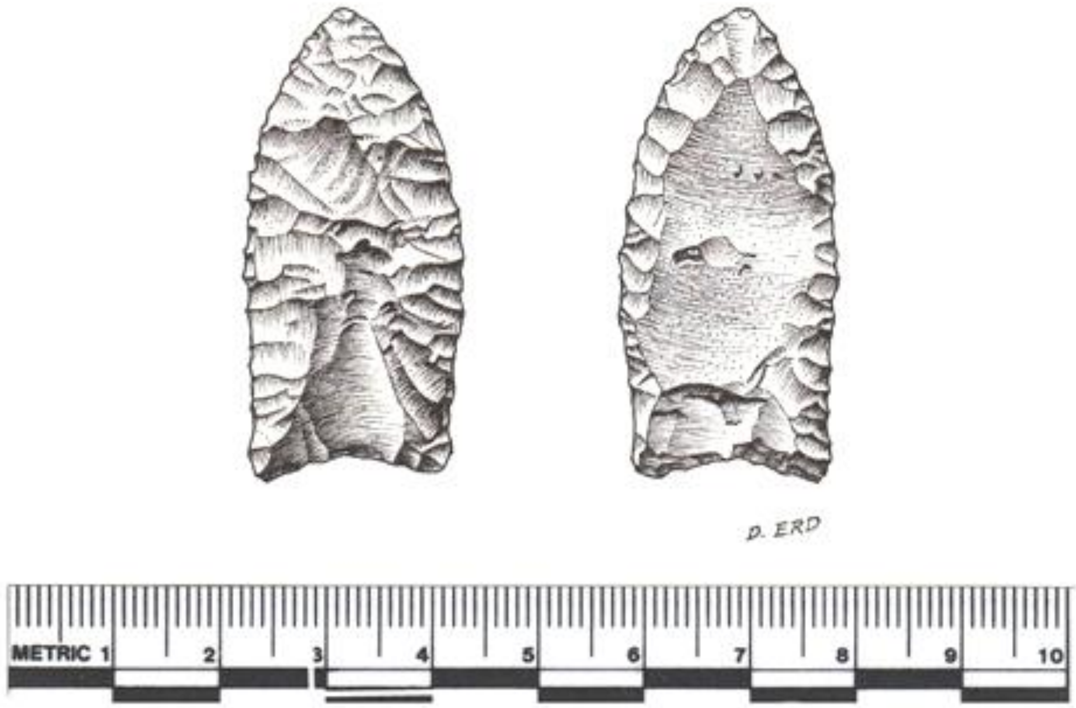


Figure 4. Clovis fluted projectile point. (Image courtesy of Darby Erd).

Clovis aged sites, in order to more fully address the uncertainty regarding the emergence and spread of Clovis technology. For early studies in the East, a number of factors often hindered the ability of researchers from obtaining sufficient organic material from associated Clovis contexts to obtain reliable dates. Thus accurate dates for these sites were unable to be obtained. As a result, early proposed Clovis sites from the East could only be identified as such based upon "typological similarity" to fluted projectile points, and dated assemblages from the West (Meltzer 2003: 539; Williams and Stoltman 1965). Recent studies however, have had more success in dating Paleoindian sites in the East, and have produced dates contemporary with the West (Waters and Stafford 2007), and in some cases earlier. At Big Eddy in Missouri the discovery of a Gainey projectile point refit in stratified context with charred remains has produced a radiocarbon date of 10,832 ± 58 ^{14}C yr B.P, and at Sloth Hole Florida Clovis diagnostics have been dated to 11,050± 50 ^{14}C yr B.P (Waters and Stafford 2007). At Coates Hines, in Tennessee, the remains of extinct mastodon found in stratigraphic association with lithic tools and debitage from the manufacture and maintenance of tools have produced dates in excess of 12000 ^{14}C yr B.P, predating a number of sites from the west (Deter-Wolf et al. 2011). Such discoveries raise a number of key questions concerning the origin and timing of the Clovis occupation of the western hemisphere.

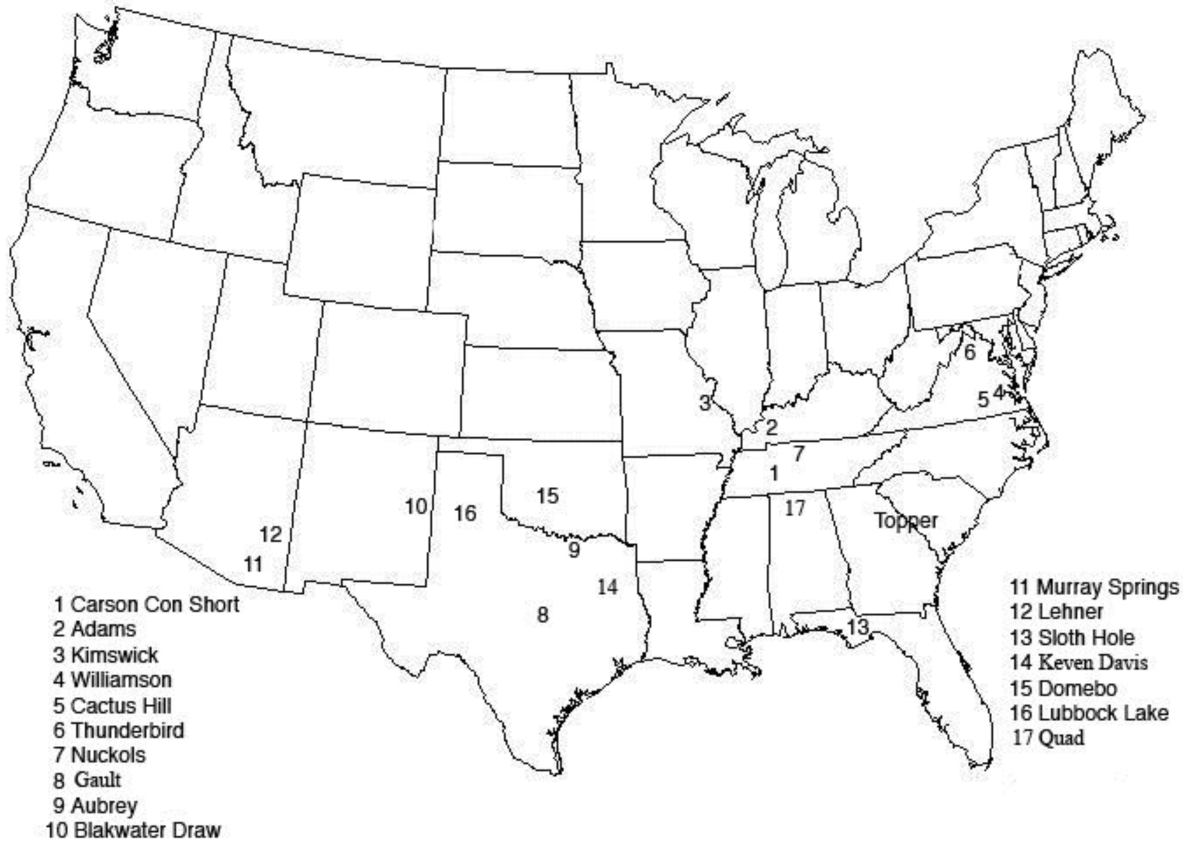


Figure 5. Selected Clovis Sites mentioned in the text.

Table 1. Clovis site types showing primary function performed at each.

Site Type	Site Function
Quarry-Related	Raw material extraction and initial lithic reduction.
Cache	Transportable resource storage.
Kill Site	Food / resource processing.
Habitation	Extended stay base camp.
Workshop	Tool manufacture.

Clovis Blade Technology at the Topper Site

Clovis Origins

The origins of Clovis have been a controversial topic among Paleoindian researchers. Key issues revolve around when and how Clovis inhabitants came to occupy North America, and several models have been put forth which attempt to explain this origin. Models of Clovis origin include: (1) a route in which people entered the western hemisphere from Siberia via the Bering strait land bridge, into Alaska, and moved through a "narrow passage" that had been exposed between the Laurentian and Cordilleran ice sheets at the end of the Pleistocene (Haynes 1969, 2005; Martin 1973), (2) a Pacific Coastal route (Fladmark 1979; Dixon 1999), and finally (3), a North Atlantic route in which early Paleoindians employed the use of boats in skirting the North Atlantic ice caps, eventually arriving in North America from Western Europe (Stanford and Bradley 2000). Others propose Clovis as emerging from pre-existing "pre-Clovis inhabitants.

Apart from an active debate concerning exactly how humans first originated in the Americas, there exists just as much deliberation regarding the timing of their arrival. Possible evidence of a Pre-Clovis occupation in North and South America is demonstrated at a number of archaeological sites such as Monte Verde in Chile (Dillehay 1997), Cactus Hill in Virginia (McAvoy 1992), Meadowcroft in Pennsylvania (Adovasio et al. 1999), and Topper (Goodyear 2005) among others. These "Pre-Clovis" sites have been intensely scrutinized, and critics cite questionable dating techniques, geologic context, and artifact credibility, as a basis for skepticism concerning claims of Pre-Clovis occupations of North America. Nevertheless, there is increasing evidence in North and South America for human occupation prior to that of Clovis (Goebel et al. 2008).

Clovis Sites

Clovis sites can be categorized according to the activities performed, and include habitation sites, quarry sites, kill sites, and cache sites (Table 1). The function a site served is identified not only by the presence or absence of specific tools, but also through its specific context with particular features of the landscape. Certain site types appear to be more prevalent in some regions than in others. Kill and cache sites, for example, seem to be more prevalent throughout the west, particularly the Plains (Kilby 2008). Clovis quarry/workshop reduction sites and sustained habitation locales appear to be more abundant throughout Eastern North America, as sources of high quality lithic material are often more widely dispersed in the West (Morrow 1994:43).

Kill sites are areas where animals were killed, butchered, processed, or a combination of these three activities. These sites are often identified by the presence of disarticulated animal bones, frequently found in association with the tools used to kill and butcher them. Where lithic tools are not present, evidence of bone modification such as cut marks or striae on these specimens is confirmation of a human presence at kill sites. Blackwater Locality No. 1 in New Mexico, and Murray Springs, Naco and Lehner (Lance 1959) in Arizona, are sites with documented mammoth kills with associated lithic tools. In the Southeast, kill sites are rare, as extinct animal remains are not often reported from this region (Walthall 1980). In areas adjacent to the Southeast, kill sites have been documented at Domebo Oklahoma (Gilbert 1979), and at Kimmswick in Missouri (Graham et al. 1981).

Artifact caches form another type of Clovis site. Most cache sites appear to be areas where tools were placed in anticipation of future situations or need (Kilby 2008). These sites are considered to reflect key uses of raw material, areas where lithic material and/or tools in various states of production were placed in strategic locations on the landscape. Habitation sites are identified as localities where groups of hunter-gatherers lived for a period of time, often conducting domestic and subsistence activities. Because a wide range of activities likely occurred at these sites, one may expect equally diverse artifact types to have been deposited (Bamforth 2002; Kilby 2008).

Areas where lithic material resources were extracted are called quarries. These areas served as replenishment and rearmament locales for prehistoric peoples, where extracted lithic material was "initially reduced for transport" (Kilby 2008:20). Quarries and quarry related activities are of interest to archaeologists as they can provide valuable information concerning prehistoric human behavior. As it pertains to the Clovis culture, such information may include approaches of lithic tool manufacture, the organization of lithic technology, and adjustments in mobility structure.

Cultural material remains often observed at quarries include waste flakes (often associated with initial stages of lithic reduction), cores, and exhausted tools. At quarries, tools no longer suitable for use would have been discarded in favor of materials of higher quality for the manufacture of new tools. Consequently, exhausted tools produced of exotic or non-local material are often recovered at quarry sites. At Topper, a number of Clovis artifacts manufactured from non-local raw materials have been identified to date (Goodyear et al. 2009) (Figure 6). Materials from which these artifacts were produced include rhyolite, and welded vitric tuff, and are thought to derive from the East central piedmont of North Carolina (Goodyear et al. 2009) Once extracted, raw material obtained from quarries could be reduced. Reduction might occur at the quarry itself, or material could be reduced into manageable forms and transported to other areas offsite.

Over time, quarries would have been repeatedly revisited when material resources ran low, or tools were exhausted. This issue, in combination with the un-diagnostic nature of lithic material often present at quarries, makes these assemblages difficult to interpret (Kilby 2008). Known Clovis quarry sites in the Southeast include Carson Conn Short in Tennessee (Broster and Norton 1996, 2009), Big Pine Tree in South Carolina (Goodyear 1999) , and Williamson in Virginia (McCary 1951). Lithic manufacture workshop sites with nearby known quarries include Nuckolls and Wells Creek in Tennessee (Ellerbusch 2004; Dragoo 1973), and Adams in Kentucky (Sanders 1990).

It is possible that each type of Clovis site served a specific function, and in some cases multiple functions. The potential that Clovis sites reflect patterns of land-use strategies is real, though must be demonstrated through systematic analyses and not assumed. If substantiated then Clovis groups may have depended upon each site for daily subsistence. As such, site locations would not have only been dependent upon the presence and availability of food resources, but also on the placement of raw material resources on the landscape.

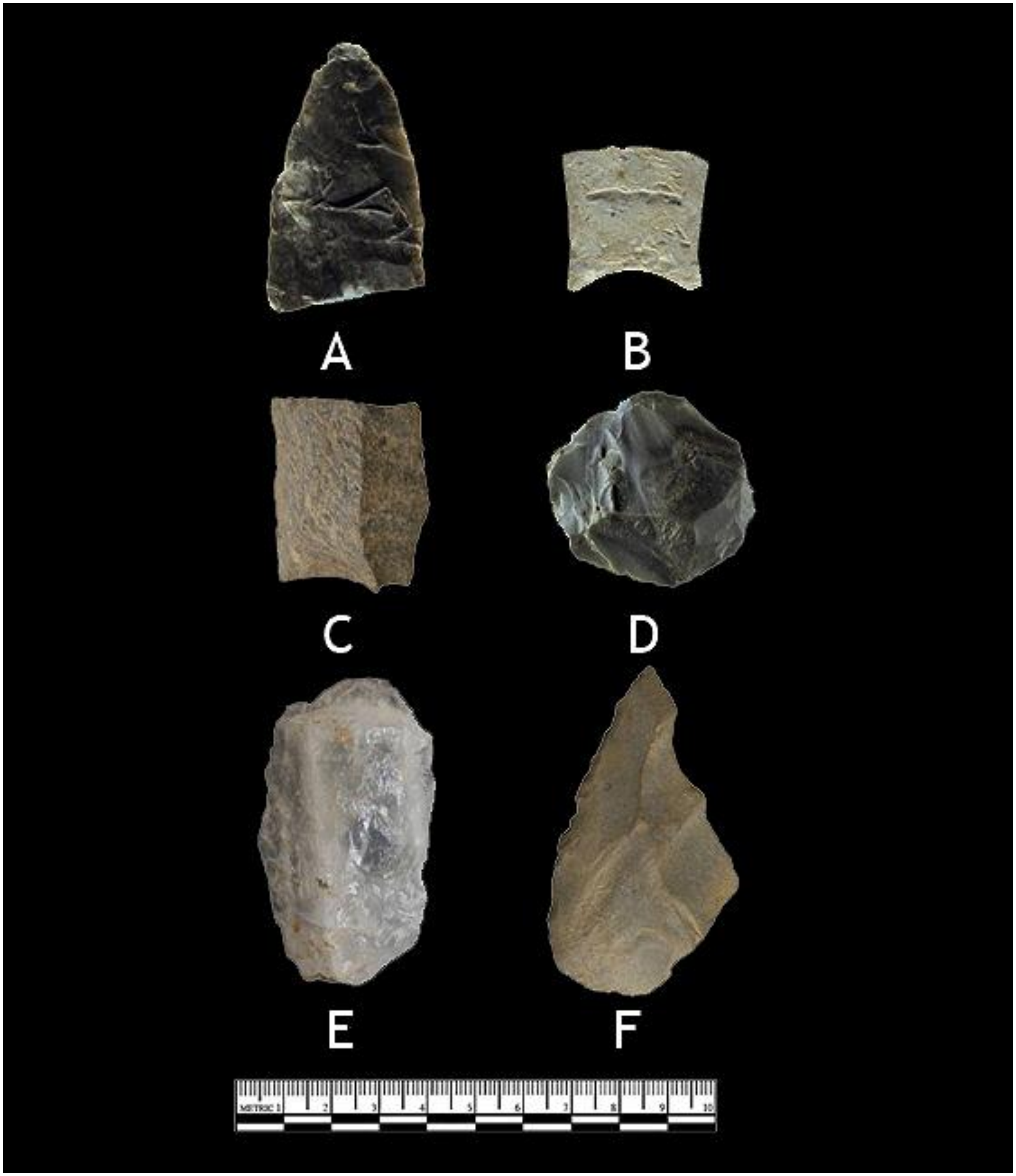


Figure 6. Clovis Artifacts recovered at the Topper site (38AL23) manufactured from non-local raw material sources. A: Clovis projectile point tip, B: Rhyolite Clovis projectile point base, C: Rhyolite blade medial segment, D: Welded Vitric Tuff scraper, E: Quartz scraper, F: Rhyolite side scraper. All artifacts from Clovis deposits. (Image adapted from photograph by Meg Gaillard, South Carolina Institute of Archaeology and Anthropology).

Clovis Subsistence

It was once widely accepted that Clovis hunters relied heavily upon megafauna such as mammoth, mastodon, and bison for subsistence needs (Martin 1984; Mosimann and Martin 1975; Haynes 1966; Wormington 1957). This view is often held as a result of the occurrence of such animals with diagnostic Clovis artifacts or features at Blackwater Draw and other kill sites. The dependence on megafauna by Clovis hunters suggests a highly specialized subsistence strategy (Kelly and Todd 1988). Recent research, (Ferring 2001; Haynes and Huckell 2007) has indicated that Clovis groups likely relied upon a variety of other smaller game, fish, and plant resources in addition to megafauna. Such a diet supports a generalist model of Clovis subsistence (Haynes and Huckell 2007; Meltzer 1993).

The Clovis diet from the Southeast may best be described as diverse, likely incorporating a variety of available resources including megafauna, smaller game, and floral species. While the reliance on large game to support subsistence needs is probable, evidence of such exploitation in the region is sparse due in part to poor preservation in many areas. Just outside of the southeast, evidence for Clovis subsistence activities has been observed at Kimmswick in Missouri, which includes a variety of remains of smaller game.

The quantity of large megafauna in any given area may be expected to vary in response to different and diverse environments, spread across space and through time. As numbers of megafauna declined through time, Paleoindian hunters may have had to adapt, incorporating broader hunting ranges, as well as exercising a diet that supports a greater dependence upon "lower ranked resources" (Haynes and Huckell 2007). If this is the case, we may expect the toolkits utilized in the acquisition and processing of a variety of resources to have been flexible, capable of being adapted to serve a number of tasks. One tool form, blades, might have served a critical role in fulfilling a variety of subsistence needs.

Lithic Technology and the Clovis Toolkit

Clovis assemblages are identified by the presence of a distinctive lithic technology, highlighted by fluted projectile points. These points are characterized as lanceolate, often having concave, ground basal margins, and are assumed to have served as projectiles. In addition to Clovis points, a number of other tool forms comprise the Clovis toolkit, which however, tend to vary in abundance and type by geographic site. Tools often considered part of the Clovis tool kit include bifaces, unifaces, scrapers, denticulates, burins, blades (Collins 1999a) and organic tools made from bone and ivory (Hemmings 2004).

Three separate lithic reductive approaches are recognized as part of the Clovis tool production industry (Collins 1999a; Sanders 1990). Here, reductive approach refers to the specific manufacture techniques employed in the production of a given end product. Reduction approaches are characterized as either producing (1) bifaces, (2) large flakes struck from generalized cores, or (3) prismatic blades struck from polyhedral, conical, or wedge shaped cores. The biface category may be further subdivided as either bifacial cores, or as stylized bifaces. Though some overlap in technique is apparent, each reduction approach serves a different purpose (Haynes and Huckell 2007:185).

Bifaces are pieces of lithic material that have been flaked on both faces. They are an informative artifact category for understanding lithic reductive approaches, and stone tool use (Dickens 2005). Clovis bifaces appear to have served three purposes. They functioned as cores for the future production of flake tools, as formalized bifaces that served as projectile point preforms (Condon 2005; Morrow 1996), and as long use-life cutting tools (Kelly 1988).

At quarries, evidence of both bifacial flake cores, and stylized bifaces should be expected. These locales served as staging areas where lithic reduction was conducted for immediate as well as future subsistence needs of the group. As such, bifacial cores would have been manufactured to serve as transportable quarries as groups moved across the landscape, and in anticipation of future situations. In this scenario, flakes suitable for use could be detached from cores as needed. "The use of bifaces as cores implies that there was a need by hunter-gatherers to prepare for situations that require a variety of tasks for stone tools", and in the absence of raw materials and time for stone tool production (Kelly 1988)."

In contrast to bifacial flake cores, stylized biface production represents a linear reductive approach, ranging from the procurement of raw material through to the completion of a finished point. Stylized bifaces are often recovered in various stages of production, and numerous authors have provided descriptions of such stages (e.g., Morrow 1996; Callahan 1979; Collins 1975; Whittaker 1994).

Generalized cores served for the production of non-specialized flakes, which may vary in size and shape. They are considered a less formalized approach than biface production. Flakes removed from generalized cores could either have been used as detached, retouched along lateral margins, or modified into other tool forms such as scrapers or gravers (Haynes and Huckell 2007). Because generalized cores exhibit little formal patterning, they are often classified as an expedient lithic technology. An expedient technology is one that produces stone tools via minimal technological effort.

A third reductive approach employed by Clovis people is the manufacture of prismatic blades struck from conical, polyhedral, and wedge shaped cores. In blade production removals are detached, often forming thin, elongated, parallel-sided flakes that could serve a number of tasks. Once detached, blades could have subsequently been modified into scrapers that functioned as hide and wood working implements (Morrow 1996), or used as unmodified cutting tools. Owing to the existence of blades found in stratigraphic context with fluted projectile points and preforms, blade manufacture appears to be a major component of Clovis technology in some regions of North America (Collins 1999a). In Chapter IV, Clovis blade technology is explored in more detail.

Technological Organization and Models of Mobility

The role of tool production and how it relates to the organization of lithic technology is a key topic in archaeological research (Nelson 1991, Bleed 1986, Goodyear 1989). Lithic technological organization refers to is the spatio-temporal placement of tool manufacture strategies within a cultural system, and includes the necessary requirements for "making, using, transporting, maintaining, and discarding tools", raw material considerations, and the role of human behavior among varying social and environmental constraints (Nelson 1991:57, Kelly 1988, Carr and Bradbury). Nelson has developed a framework for lithic analyses that incorporates an "organization of technology approach" (Nelson 1991, Carr and Bradbury:127). In her framework (Figure 7), Nelson depicts multiple levels of analysis. At the top, are the environmental conditions that play a role in the "problem solving processes" that are chosen in favor over others (Nelson 1991:57). Resource predictability, distribution, mobility, and patch size are environmental conditions that one must consider when given the choice between different technological strategies. The second tier in Nelson's hierarchy depicts social and economic strategies, and considers concepts including optimization as a means of adaptation, risk, reciprocation, and style as variables that influence decisions in human behavior. At the lower level of Nelsons hierarchy are analyses that examine technological strategies. These include curation, expedience, and opportunistic behavior, and are discussed in detail in the following section. Technological strategies are further categorized as those that can inform about artifact design and activity distribution, which in turn may inform about artifact form and artifact distribution. Thus, if we obtain some knowledge on artifact form, we may use such insight to gain a broader understanding about the strategies employed in tool design, "then social/economic strategies, and finally environmental conditions" (Carr and Bradbury 2001:127). An examination of the technological strategies employed in the manufacture of blades has the potential to inform about broader social and economic strategies.

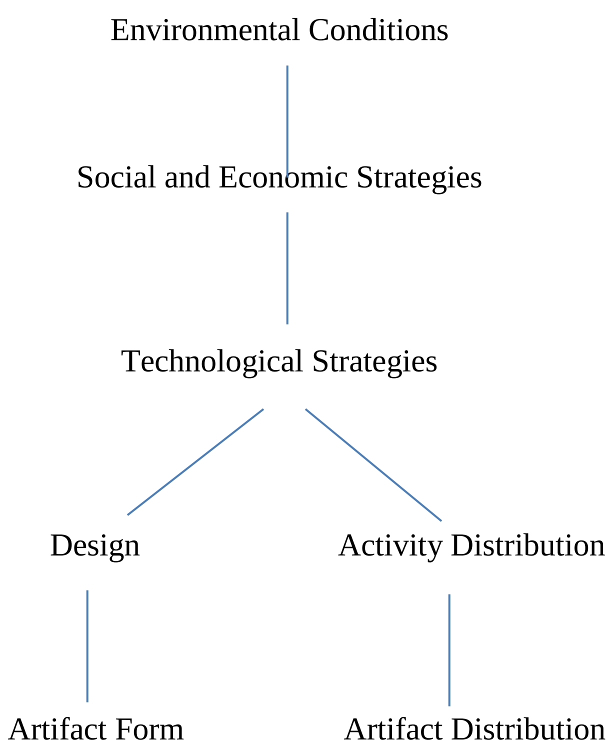


Figure 7. Levels of analysis for research on technological organization. Adapted from Nelson 1991.

Nelson's framework has implications on the relationships between population movement and environmental constraints placed on stone tool procurement, production and transport (Nelson 1991). Human mobility and settlement decisions were directly linked to environmental constraints. In other words, the patterns in which prehistoric people moved across the landscape affected their choices in how, when, where, and what tools were produced. Factors such as raw material location and availability, distance to source, time necessary for tool acquisition and production, and portability and transport are all environmental constrains that influence decisions in Paleoindian settlement and mobility. Social and economic considerations that likely impacted settlement decisions include subsistence requirements as well as risks involved in resource acquisition. Further, technological strategies that condition tool design, artifact form, and ultimately activity and artifact distribution are all concepts that are linked to mobility.

Nelson provides a detailed description of three technological strategies employed when considering tool production. These strategies include curation, expediency and "opportunistic behavior" (Nelson 1991:65). Nelson defines curation as the advanced planning or "caretaking" of tools, and is differentiated from an expedient technology by the preparation and manufacture of tools in *anticipation of future use* or in inadequate conditions (Nelson 1991:65). Shott (1996) however suggests the abandonment of the phrase "anticipation of future use" as it is inadequate for informing about assemblage formation or behavior" (Shott 1996:264). Rather, Shott defines curation as:

"the degree of use or utility extracted, expressed as a relationship between how much utility a tool starts with, its maximum utility and how much of that utility is realized before discard" (Shott 1989[b]:24, 1995).

However, curation includes the advanced planning decisions involved in "manufacture, transport, reshaping, and caching or storing" of stone tools or toolkits, and lessens the inconsistency between raw material and tool availability and the "location(s) of tool use. (Nelson 1991:63). In contrast to curation, expedient strategies refer to the "manufacture, use, and abandonment of instrumental items in the immediate context of use" (Binford 1977:34). Such strategies should employ "minimal technological effort" under circumstances where the location, period, and duration of use are predictable (Nelson 1991:63, Bleed 1986; Parry and Kelly 1987). Whereas curation forestalls the expected necessity of tools at locations of use, expedient technologies rely on the "anticipated placement of activities adjacent to raw materials", little or no time stress for tool manufacture, and long term or recurrent use of a particular site as a means to take advantage of extant raw materials (Nelson 1991:63). Tools are therefore manufactured and used at the time and place of need and not in anticipation of their need.

A third strategy is opportunistic technological behavior. Opportunistic technologies are the result of sudden and unexpected situations that require immediate responses. The loss of a required tool to complete an unplanned task, and the subsequent replacement of such tool under raw material constraints is one example of opportunistic behavior. While curated and expedient strategies reflect "planning options that suit different conditions within a set of adaptive strategies", opportunistic behavior occurs in response to immediate, unanticipated conditions, and therefore no planning is involved (Nelson 1991:65).

A number of assumptions regarding Clovis are based on the distinction between blade and non-blade technologies. Flake production is most often considered an expedient lithic technology, producing tools in the immediate context of use, and given little technological effort in their production. We therefore may assume that a generalized flake technology, practiced among Clovis groups of the region, reflects less importance given to time for the manufacture of tools than formalized technologies, and relies upon the placement of reductive activities immediately adjacent to lithic resources. In contrast, biface and technological blade industries are curated technologies, whereby the end products are transportable for use as needed. Evidence for both expedient and curated technologies is common among Clovis assemblages. Both biface and blade technologies would have offered Clovis groups diverse yet beneficial toolkits in different situations. By differentiating the attributes consistently found for each technology, as well as the distribution of artifacts onsite, it is possible to form a broader understanding about how Clovis inhabitants organized their lithic technology in the Savannah River Valley of South Carolina.

The concept of design is important when formulating strategies of lithic tool production and technological organization. According to Nelson, design refers to "a set of variables of utility that condition the forms of tools and composition of toolkits" (Nelson 1991:66). Nelson recognizes five categories of design inherent to decisions in tool production: Reliability, maintainability, flexibility, versatility, and transportability (Nelson 1991). Reliable tools are those that are dependable when needed (Bleed 1986) and that maximize tool use time in relation to time required for maintenance. Reliable designs are most appropriate for attaining resource returns when there exists a "premium on capture and processing time", and must be able to endure specific stresses when encountered (Nelson 1991:67; Bleed 1986:739). Such designs work best when the cost of tool failure is high. The manufacture of a tool for repeated use under predictable, scheduled situations is an example of a reliable tool design. Though dependable, reliable designs do have some costs that may make tools "less optimal in some situations" (Bleed 1986:740).

Maintainable designs are developed to function comfortably under a wide range of different conditions, and must anticipate the replacement of working parts at some point in the future. For example, if a tool is broken, a maintainable design can allow for the tool to be repaired to a functional state once again, or to work at partial capacity (Bleed 1986). Though simpler than reliable design strategies, maintainable tools are also less costly in manufacture time than reliable designs. They are most suitable for tasks that require a "continuous need, but under unpredictable schedules" (Carr and Bradbury 2011:310). According to Bleed, maintainable tools are typically designed to perform a range of activities, and tend to be portable. Though they may operate differently under varying conditions, Bleed stresses that reliable and maintainable design strategies are not opposite points along a single continuum. Rather these concepts represent alternative strategies chosen in response to different environmental situations (Bleed 1986). For example a given tool may be designed with emphasis given to applying some basic features of reliability, though add to it aspects of maintainability in the event the tool fails when needed.

In addition to reliable and maintainable designs, the capability of tools to serve as flexible or versatile functions must be considered in the total design system. The concept of a flexible design refers to the ability of tools to change in form in order to attain specific multi-functional demands (Nelson 1991). In contrast, versatile tools are those that are "maintained in a generalized form to meet a variety of needs" (Nelson 1991:70). Both versatile and flexible tools have multiple tool-use selections. Because versatility requires an edge form or a tool with a number of different functional edges (Nelson 1991:73), modified blades can meet the design features of versatility. Finally, transportable designs operate to alleviate the constraints placed on mobility. Accordingly, tools are brought to the location where a given task is to be carried out, rather than manufactured at the task location. As will be discussed in chapter III, a number of variables of utility in the design process have important implications for blade manufacture and steps involved in the blade reduction sequence.

If Clovis was a highly mobile society, relying on vast and diverse areas of the landscape for survival, then there would have likely been a need for access to lithic raw materials of high quality, and in adequate sizes to allow for the production of tools (Goodyear 1989). Such materials were not uniformly distributed across the landscape, much less corresponding to areas of required subsistence such as mega-fauna. These issues likely posed logistical problems for Clovis groups (Kilby 2008). To combat these constraints, a "transportable" tool design was developed. Such a toolkit includes those items that could support a number of tasks when needed, and that is also portable relative to utility (Rasic and Andrefsky 2001:64).

The relationship between portability and utility refer to issues of tool size and mass relative to the costs of other daily essentials (e.g. food, gear). If a tool kit is too bulky to allow for the transport of other necessities, regardless of efficiency, then it may be a detriment to the procurement and acquisition of other resources. Consequently decisions in tool design must also take into consideration unexpected situations or encounters, and are therefore, largely dependent upon risk. Bamforth and Bleed (1986) provide a detailed synthesis on risk as it relates to strategies of technological organization. According to Bamforth and Bleed, risk in tool production is relative to the probability of failure, and to the consequences of such occurrences (Bamforth and Bleed 1997). "Accordingly, strategies in lithic tool production that decrease failure probabilities while not completely limiting technological options, are those that are favored" (Bamforth and Bleed 1997:116). Therefore a balance is sought between the costs of raw material acquisition, tool production, and subsistence requirements. In situations where raw material is scarce, or access to it is limited, tool design should "stress attributes that allow used tools to undergo maintenance and rejuvenation on short notice (Bamforth and Bleed 1997:116).

This research is focused upon blades and Clovis blade technology. The present analysis will test the degree to which raw material constraints affected blade design and mobility structure at Topper and within the Savannah River Valley of South Carolina. It will also assess the extent to which specific design strategies (i.e. reliable versus maintainable, and flexible versus versatile) conditioned tool form at Topper. For example, were blades specifically designed to withstand repeated uses over short recurring activity intervals, while serving a limited range of tasks, and under predictable situations? If so, we should expect little evidence of maintenance on blade tools. In contrast, were blades designed to serve a continuous need, capable of performing a wide range of tasks when required, though in unpredictable environmental situations? Or, were such tools designed using some combination of both strategies. A comparison of blades from Topper, to those recovered from the broader region may provide insight into the particular design strategies carried out in blade production by Clovis inhabitants of the region. If blades were produced at quarries such as Topper and were subsequently transported for uses off-site, then one should expect a greater emphasis given to maintainable design strategies as the distance increases between task activities and replenishable raw material resources. This analysis may further enlighten on the potential of blade analysis to offer inferences regarding aspects of social and economic strategies in the organization of lithic technology. In the following chapters Clovis blade technology and blade research will be explored in detail.

Chapter III

CLOVIS BLADE TECHNOLOGY AND HISTORY OF RESEARCH

A blade is a specialized type of lithic flake product resulting from the reduction of a specifically designed core. Blades (Figure 8) are elongated flakes, having parallel lateral margins. They have two or more parallel scars of previous blade detachments on the exterior surface, with compression lines radiating from the direction of applied force (Crabtree 1972). Cross sections of blades are triangular to trapezoidal in form, and platform remnants are often 60 degrees or greater. Because lithic reduction can result in a variety of detached pieces, it is important to note that blade manufacture refers to a specific design technology, as opposed to only an artifact type. Blade technology is defined as the knowledge necessary for the production of an explicit, systematic, and intended type of lithic detachment (Collins 1999a:9).

Blades are highly useful blanks for a variety of cutting and scraping tools (Collins 1999). Functions that blades may have served include slicing, cutting and scraping, related to working organic media such as skin, meat, wood, and bone. A combination of specific attributes, including but not limited to sharpness, evenness and possessing acute lateral margins, creates a versatile tool form that allows blades and tools made on blades to be used for various tasks (Whittaker 1994, Collins 1999a). Moreover, blades are also efficient uses of raw material in terms of total length of cutting edge from a given mass of stone (Sheets and Muto 1972; Whitaker 1994; Collins 1999a). If cutting edges become dull through use, simple maintenance by retouching the blade margin allowed additional use-life for such tools, while not inhibiting its ability to perform intended functions. Blades serve an advantage over flakes produced from amorphous cores in a number of design variables. Unlike flakes, blades are intentionally manufactured to have straight, parallel margins that maximize the length of cutting surface per edge. Such margins are reliable when needed. In contrast, flakes have margins that may be irregular in form, and pose unforeseen problems or variability when cutting or slicing through materials. Because of their uniform nature, blades can function easily under a wide range of different conditions. Moreover, due to the consistent, even form of their lateral edges, blades may be maintained to meet a variety of needs, though may be modified in form to attain specific multi-functional demands. Finally, because of their standardized outline, blades and blade cores may be more readily transported than flakes whose size and thicknesses may vary.

In this chapter, blade technology and the manufacture of Clovis blades is discussed. Special interest is given to the steps involved in successful blade detachment. Such steps include raw material procurement, preparation, detachment mode, equipment type, and technique (Collins 1999a). This chapter is concluded with a brief discussion on lithic reduction, and how it can lead to inferences regarding technological organization and site function.

Blade Manufacture

Raw Material Procurement and Core Preparation

Approaches involved in the manufacture of blades, and all lithic tools, begin with decisions in raw material procurement. In essence, the size, shape, and material properties of any given objective piece (core) influence the outcome and success of

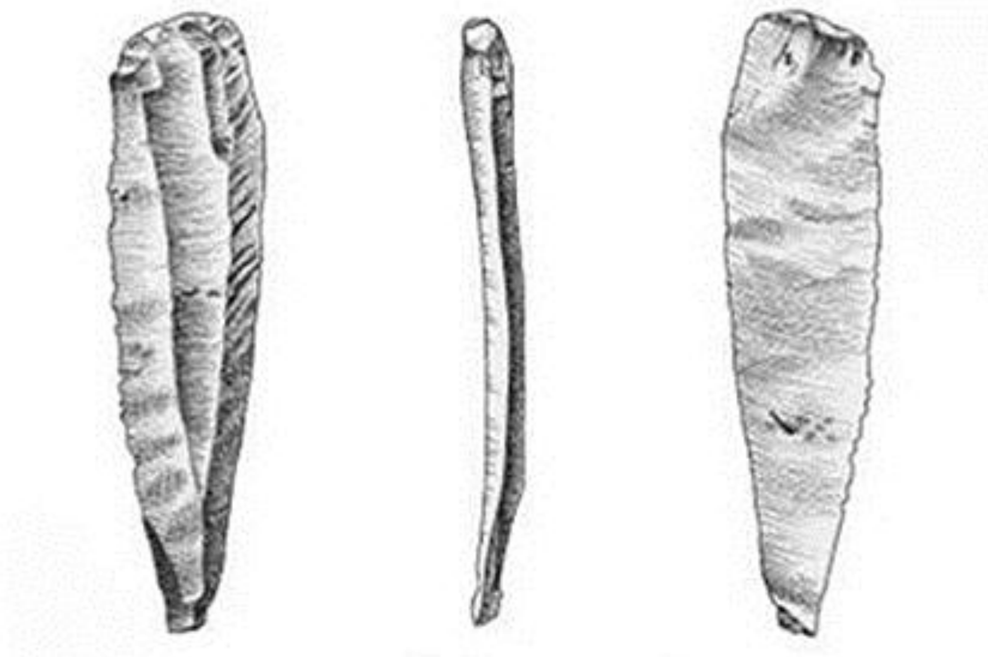


Figure 8. Illustration of a Blade. Blade attributes include parallel lateral margins, two or more scars of previous blade detachments on the exterior surface, and cross sections that are triangular to trapezoidal in form. Image credit Southeastern Paleoamerican Survey (SEPAS).

a blade removal. Stone must be tabular or spherical in shape (Collins 1999a; Dickens 2005). If spherical, it is necessary for the material to be split, creating a flat surface from which blades may be detached. Furthermore, since fracture tends to follow ridges (Whittaker 1994:220-221), nodules that have at least one natural ridge are desirable. A second criterion of raw material is that of size. Raw material must be large enough to allow for the removal of blades in sufficient length to serve their intended functions. Thus if raw material is too small, lithic production may be limited.

Just as important as size and shape are the internal properties of raw material. The production of blades is best achieved when raw material is "homogenous, lacking in inclusions or flaws, is elastic but brittle, and fractures conchoidally" (Whittaker 1994:65-66). Materials that do not possess these attributes are more prone to failure when attempting to strike a blade from a core. Hinge and step fractures are common errors that often occur when raw materials do not meet such qualifications. Once suitable raw material has been selected, initial core preparation is the next step in blade production. Initial core preparation refers to the sequence of removals, modification, and rejuvenation of the core platform that will necessitate the production of a successful striking platform and guide ridge for the detachment of a blade to follow. Blades are produced through detachment along a ridge either naturally occurring, purposefully formed, or as the result of previous flake removals (Bordes and Crabtree 1969:4). Bifacial or unifacial flaking may be necessary to produce a ridge, or strengthen one in such cases where the ridge is irregular

(Dickens 2005). Since fracture of lithic material will often follow a ridge, specimens that appear as blades may actually be the result of flake or biface manufacture, as opposed to a standardized blade technology (Dickens 2005; Jelinek 1981:155).

A platform refers to the surface of an objective piece that is struck either directly or indirectly with a hard or soft percussor, or through pressure. Platforms either occur naturally on the objective piece, or are produced through preparation (Patten 1999). Natural platforms are pre-existing flat surfaces on a piece of raw material. A suitable platform for blade production provides an acute angle between the core face, and the area of contact. An exterior angle that is close to 90 degrees results in longer blade detachments (Collins 1999a:22; Dickens 2005:129; Whittaker 1994:223). The larger the platform angle, the less likelihood there is for successful blade detachment to occur. Once detached, a blade will often retain a piece of the core platform at the proximal end referred to as the platform remnant. Thus, the platform remnant of a blade represents the point of contact between the objective piece and percussor. Blades produced from natural core platforms (Figure 9 A) often exhibit evidence of cortex on their platform remnants suggestive of initial or early stages in the manufacture trajectory. If a natural platform does not exist, one is created either through the removal of one end of the objective piece (Figure 9 B), or by isolating an area through the process of flaking along the core margin (Bordes and Crabtree 1969:5; Dickens 2005:129). For those specimens in which it is necessary to remove an end, such removals are referred to as core tops or tablet flakes (Figure 10). If a successful core face/platform angle is not produced upon the initial removal of a core top, further preparation in the form of flaking may be required (Whittaker 1994:224; Dickens 2005:129). Moreover, it is often necessary to grind the platform with an abrading stone. This process acts to strengthen the top of the platform, allowing more precision when detaching a blade.

Manufacture Technique

In lithic manufacture, technique refers to the means by which force is applied during detachment, and includes the implements used, as well as the direction, angle, and amount of applied force (Boldurian and Hoffman 2009). Blades can be produced through direct or indirect percussion, using pressure, soft hammer, or hard hammer modes (Newcomer 1975). Direct percussion refers to striking an objective piece with an implement. Experimental studies (Boldurian and Hoffman 2009) have shown that soft hammer direct percussion such as with antler, wood, or bone can sometimes produce specific and identifiable attributes on detached blades. One such attribute is curvature. Though blade curvature is influenced to an extent by raw material shape, Boldurian and Hoffman have found that that this attribute may be used to "infer how artisans held the core and applied force during manufacture" (Boldurian and Hoffman 2009:167). Collins suggests that blades produced using soft hammer percussion are often curved in cross section, have diffuse or no bulbs of force, and smooth interiors, attributes not often found on blades detached through hard hammer percussion (Collins 1999a). Hard hammer percussion, often employed through the use of a hammerstone, frequently results in blades with crushed platform remnants and salient bulbs of force.

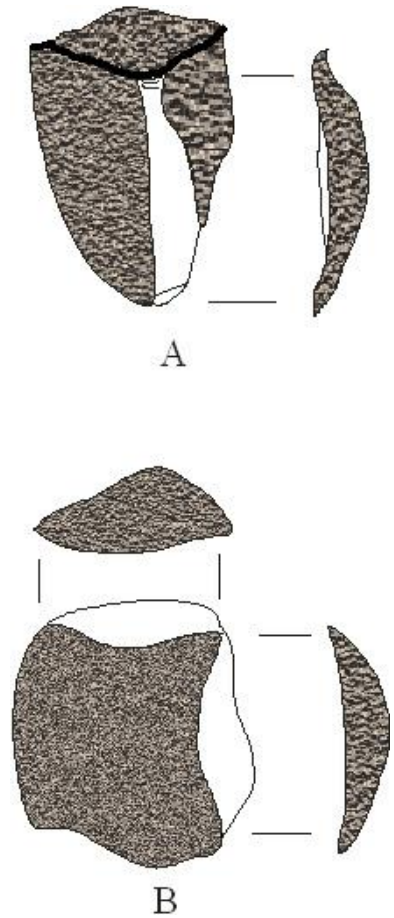


Figure 9. Diagram illustrating methods of core preparation. A: Blade detached from a core with a natural platform. B: A blade detached from a platform, prepared through the removal of the natural top surface.

In indirect percussion, the objective piece is held secure, and a punch is used to remove a blade from the core. This is achieved by placing the punch directly on the core platform near the platform/core face juncture, with the direction of force applied down and away from the core. This technique is described in detail by Crabtree (1967). According to Collins, blades detached through indirect percussion are often less curved in cross section, and exhibit acute platform angles of approximately 70 degrees (Collins 1999a; 1999b). Moreover, the platform remnants of blades detached with the aid of a punch are often small. Experimental analysis suggests however, that blade attributes may not always differentiate direct from indirect means of percussion (Dickens 2005; Newcomer 1975:100; Whittaker 1994:224). In addition to direct and indirect percussion, pressure may also be used to detach a blade from a core. In one commonly employed form of this technique, a crutch with a handle and tip is placed atop the ground platform margin of an immobilized core. Pressure is then exerted down and out, with the hands and chest upon the crutch, detaching a blade. Because of the small area, in addition to location and direction of

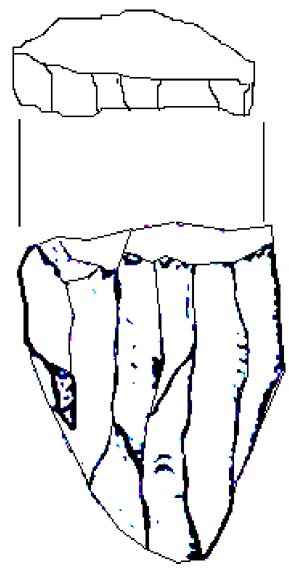


Figure 10. Core tablet (top) and blade core.

applied force, blades detached using this technique typically have small platform remnants and are curved in longitudinal profile. Originally, Collins suggested that Clovis blades were the product of indirect techniques of percussion, as direct percussion can easily miss the intended area of impact (Collins 1999a; Dickens 2005). Subsequent analysis has revealed that this may not always be the case and that either technique can produce blades having attributes similar to those of Clovis (Collins and Lohse 2004). As hard hammer percussion often results in the production of blades with wide, deep striking platform remnants and prominent bulbs of force, this technique is not thought to have been employed in the manufacture of Clovis blades. Clovis blades are therefore, thought to be a product of both direct soft hammer, and indirect techniques of percussion.

In addition to the different techniques (hard hammer, soft hammer, pressure) used in the detachment of a blade, how one holds or immobilizes the objective piece is equally important, and largely affects the outcome of any blade detachment. An objective piece, when struck directly with the object in hand, is likely to result in blades that display increased longitudinal curvature (Boldurian and Hoffman 2009:167). This comes as a result of movement or rotation of the core as it is in the process of being struck (Whittaker 1994). If, on the other hand, the objective piece is immobilized, blades are detached that tend to be less curved in cross section.

Blade Detachment and Core Rejuvenation

A blade or flake is detached from an objective piece through the use of force (Andrefsky 1986). Such force produces ripples that traverse outward from the point of impact and inward into the objective piece. Moreover, it also produces a characteristic break in the material known as a conchoidal fracture. Separation of a blade or flake only occurs when the strength of energy, as a result of force, surpasses that of the strength of the material (Speth 1972). If properly prepared, and struck with precise and sufficient force, an initial blade detachment will follow a guide ridge, either naturally occurring, or produced through flaking. If successful, it will follow along the core face, terminating at the opposing (distal) end of the core, creating two additional ridges for subsequent removals to follow. In some cases, blades will terminate in hinge or step fractures, the result of error, improper preparation, or material flaws. In extreme situations, a detachment will roll or plunge inward into the core, removing a portion of the distal end, and potentially making the core unusable.

Subsequent to each blade detachment, a negative bulb is created at the core face/platform juncture. This appears as an indentation just below the proximal end of a blade scar on the core. The negative bulbs of multiple blade detachments may form a protrusion at the core face/platform juncture, and can inhibit future blade removals if not corrected (Collins 1999a:23). Furthermore, unsuccessful blade detachments often result in hinge or step terminations along the core face (Dickens 2005). It is therefore, necessary to trim the core platform periodically to insure to future successful removals.

As multiple blades are detached from a core face, the proximal or striking end of the core becomes blocky, inhibiting the ability for the knapper to detach a blade. Eventually, if not corrected, it may become necessary to rejuvenate the core to enable future blade removals. This behavior is one form of core maintenance. The rejuvenation process entails the use of the face of the core as a striking platform to remove either all or a portion of the blade core platform (Collins and Lohse 2004). When successful, a core tablet flake is removed, (the flaked surface of the top of the core) creating a fresh flat surface for additional blades to be struck. It may take several attempts to remove a core tablet, and it is often difficult to interpret if such a removal represents an unsuccessful tablet removal, or a successful platform preparation flake (Collins and Lohse 2004). Additional core maintenance involves intermittently striking blades from opposing ends of the core. This tends to compensate for any escalation in blade curvature. Moreover, core maintenance reduces the chance of hinge and step fractures that may create an impasse for subsequent blade removals (Collins 1999a:23). In summary, blade manufacture follows four basic stages. These include the preparation of a striking platform, creation of a ridge along the core face, blade detachment, and subsequent core rejuvenation between blade removals (Bordes 1968; Bordes and Crabtree 1969; Newcomer 1975). Furthermore, each stage produces distinctive items whose attributes are potentially recognizable in the archaeological record (Collins 1999a).

Core Types

A core is defined as "a block of raw material from which blades, flakes, or bladelets may be detached" (Tixier 1974:14). The strategies chosen in blade manufacture may result in a variety of core forms. Core forms can be described in relation to their morphology (size and shape), the direction blades are struck as indicated by the negative removal scars on the core face (uni-

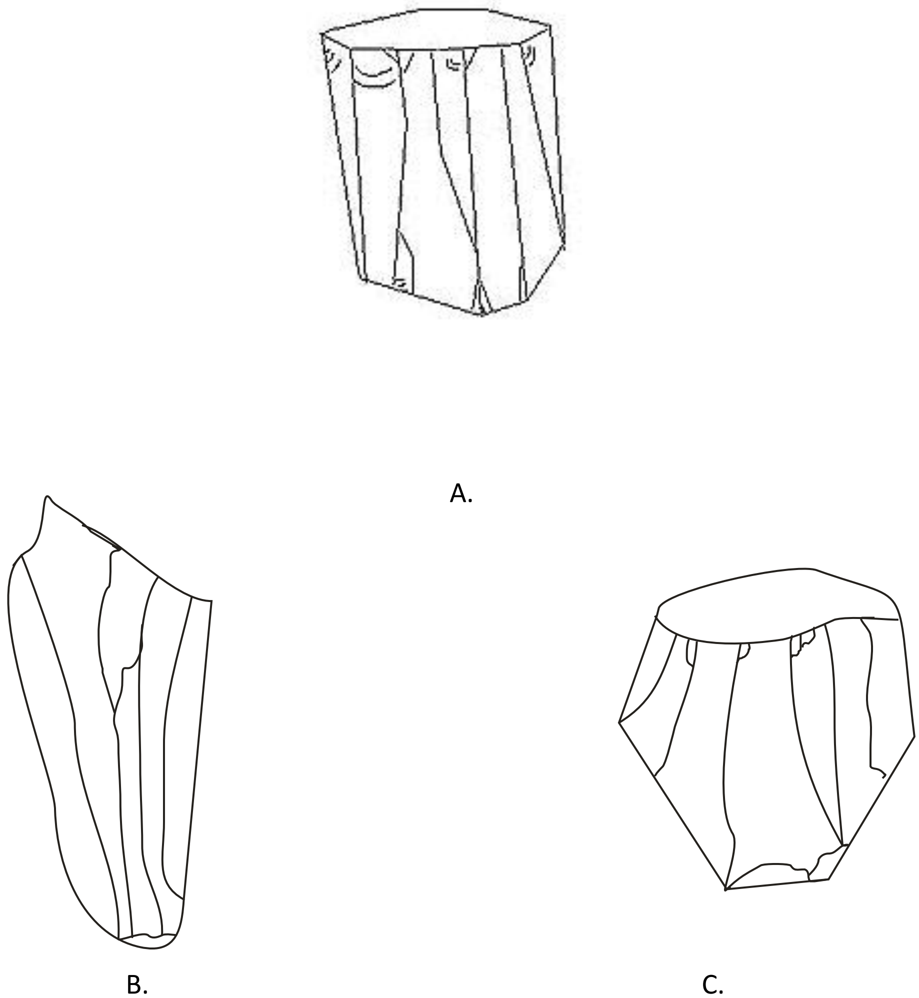


Figure 11. An illustration showing classes of Clovis blade cores. A. Cylindrical shaped core, B, a Wedge-shaped core, and C. Conical core

directional, bi-directional), and by patterns of core maintenance. Such forms include conical, wedge and cylindrical shapes. Prepared cores (Figure 11) used in the manufacture of blades have at least one prepared platform and evidence of previous blade removals on the exterior face of the core (Collins and Lohse 2004).

In his study devoted to Clovis blade technology, Collins identified two core types that have been utilized in the production of Clovis blades (Collins 1999a).

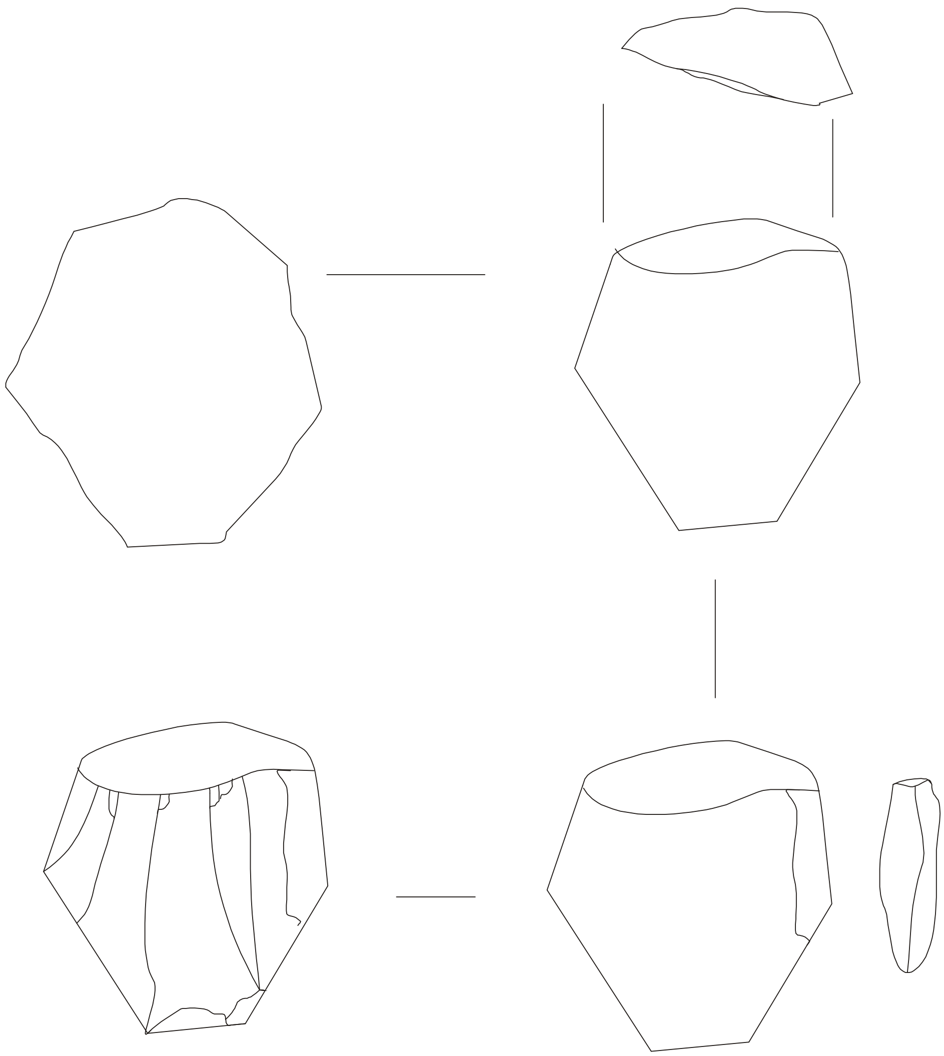


Figure 12. The manufacture trajectory used in conical blade core production.

These are conical and wedge-shaped cores. Conical blade cores have blade removals struck from a single platform that forms a base, and which form right angles to the core face (Dickens 2005). In this method of blade manufacture, cores are prepared such that a series of detachments can be produced about the circumference of the core (Figure 12). With each removal, a new ridge is developed on the core face that will help guide future detachments of additional blades. This sequence of reduction results in blades that progressively exhibit parallel straight edges and that are prismatic in cross section (Collins 1999a:26).

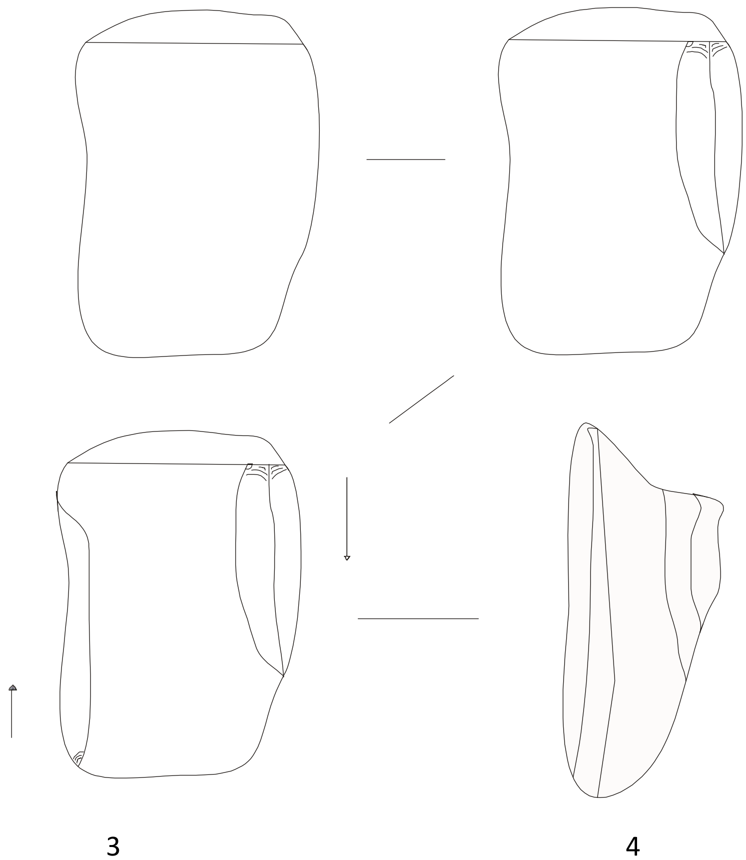


Figure 13. Manufacture trajectory employed in wedge core production.

This method allows for the maximum amount of blades to be produced from one core, and is a very efficient method of blade manufacture. Hill (2002) suggests that conical cores utilize lithic material more economically than other core forms, and as such, one should expect to find conical cores at distances from the quarry (Hill 2002:7). Collins describes conical cores as generally large, with the plane of the platform perpendicular to its axis and proximal blade facets (Collins and Lohse 2004:160). Unlike conical cores, a wedge-shaped blade core (Figure 13) has a platform that intersects the primary axis at an acute angle. In addition, blades struck from wedge shape cores may be removed from opposing platforms, rather than a single platform as occurs in conical blade production (Collins 1999a:51; Dickens 2005:11). As such, blade removal scars may be bi-directional or overlapping. Otherwise, evidence suggests that wedge-shaped cores were rarely in need of core rejuvenation (Collins and Lohse 2004). In an analysis to determine the preference of one core form over another among identified Clovis assemblages, Collins initially found conical cores to outnumber the wedge-shaped variety (Collins 1999a). Further analysis (Collins and Lohse 2004) however suggests that this may not be the case, and that the predominance of one core form over another varies regionally.

The technique employed in blade manufacture, whether direct or indirect, is thought to result in distinctive attributes for both conical and wedge-shaped cores. For example, according to Collins (1999b) "some Clovis blades have minute platforms, whereas others have wider ones" (Collins 1999b:17). "It should be stressed that it is not yet possible to identify a blade as a product of wedge or conical core production, given that the technological attributes of each core form, (with the exception of directionality) are so similar that any potential comparisons between cores and blades are speculative at best (Collins 1999b: 17)."

Apart from conical and wedge-shaped cores, a cylindrical core (Figure 14) is another core form resulting from the manufacture of prismatic blades. Cylindrical cores have multiple parallel uni-directional blade removal scars on the exterior face of the core that were detached from a single platform. Like on conical cores, blades were detached cores around the circumference of the core face. However, cylindrical cores do not exhibit a tapered end. Rather, flake removals were taken from the distal end of the core to overcome error and serve to rejuvenate the core. Thus, cylindrical cores have two opposing platforms rather than a single platform, though only one is utilized for the detachment of blades.

It is important to note that raw material selection and availability may affect the techniques chosen in blade manufacture, and ultimately the resultant core form. For example, Dickens found that wedge shaped cores from the Gault site in central Texas are more often produced from "slab-like tabs" as opposed to blocky forms that are used in conical core blade production (Dickens 2005:197). As such, the raw material form available to Clovis groups may have influenced decisions in blade manufacture.

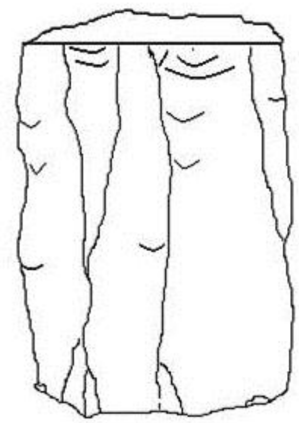


Figure 14.
Cylindrical blade core.

Reduction Stage

Reduction stage refers to the progressive order taken in the process of lithic production, and attempts to classify changes in morphological and technological artifact attributes.

While a strategy of lithic production implies a conscious means to some end (i.e. curated blade production, biface manufacture, expedient flake production), the reduction sequence refers to the implementation of a given strategy (Baumler 1995:13, Clarkson 2007). Lithic tool manufacture is a reductive (subtractive) technology, and as reduction progresses, certain cognitive decisions in core maintenance, rejuvenation, and how the core was held must be made so as to decrease the likelihood of error, overcome it, and to achieve a final product. The results of these decisions are often observed in artifact morphology. Therefore, methods that can assess morphological attribute change relative to reduction sequence are important. They can lead to interpretations regarding tool versus core production (Carr and Bradbury 2000), time and energy expenditure in the production of lithic tools, and ultimately broader issues of technological organization, human behavior, and site function (Kilby 2008).

A number of analytic methods have been developed to assess changes in raw material form and sequences of reduction in the manufacture of stone tools (e.g.). One approach, *Chaines operatoires* seeks to "reconstruct the organization of a technological system through examining the succession of mental operations conducted as a means to satisfy a given need" (Perles 1987:23). Briefly, the purpose of this approach is to "understand all cultural transformations" a given raw material passes through in the chronological process of raw material procurement, reduction, tool use, maintenance, and discard (Sellet 1993:106). As it relates to reduction stage, a goal of *Chaines Operatoires* is to describe all potential reduction choices and steps in the process of reducing a nodule, to understand the role of each as it pertains to the total lithic system, and to characterize each step by "one or a series of end products that refer to a specific stage within the process" (Sellet 1993:108). Such an approach has implications for understanding the role of curation within the organization of a lithic technological system, which in turn may provide a framework for developing interpretations regarding the decision making processes of prehistoric groups. *Chaines operatoires* differs from typological methods that only have descriptive value and that simply place specific attributes within a chronological sequence within a lithic system (Sellet 1993). Rather, *Chaines operatoires, as* an analytic tool for identifying the dynamics of the whole of a technological system, has heuristic value.

One common approach used to measure reduction is to classify the number and characteristics of flake removals present on an artifact surface. It is then possible to use this information to infer the stage in the reduction process that the piece was removed. One method is to calculate the amount of cortex observed on the exterior surface of detachments (Dibble et al. 2005). Cortex is the naturally weathered exterior surface of raw material. Specimens that exhibit high percentages of exterior surface cortex represent initial or early stages in the reduction sequence. Intermediate stages of reduction are identified by lower percentages of exterior surface cortex, and by some signs of previous removal scars. Late stage lithic debitage should show no evidence of cortex, and have multiple scars of previous removals on the exterior surface. Such measures of reduction can evaluate cortex as an actual percent total, or as sequential stages (primary, secondary, tertiary) in the reduction process. Models that evaluate the amount of cortex work well when the core or objective piece is rotated, and detachments are taken in sequential patterns around the circumference of the core. However, reduction may not always follow in the same procession. For example, a core may be reduced, focusing reduction on the same face, thus producing both cortical and non-cortical debitage. Once the core is rotated and cortical reduction resumes, debitage resulting from various sequences in the reduction process may be deposited non-sequentially such as platform facet scars. It is essential, therefore, to use a combination of attributes, including number of exterior surface scars when attempting to establish the sequence of reduction represented by a given assemblage.

Blade curvature has been recognized as an important attribute in identifying lithic technological processes, and correlating sequences of reduction (Andrefsky 1986; Crabtree 1973). Curvature is identified as the arc formed along the interior surface of a blade, and reflects mechanical properties of raw material size, fracture initiation, as well as design strategies considered during reduction (Andrefsky 1986). In the production of blades, as a core is reduced, its mass decreases not only along the face, but also at the proximal and distal ends. This process results in the manufacture of blades that exhibit larger indexes of curvature as reduction progresses. Like cortex and curvature, measures of blade length may be used as indicators of reduction. As core reduction progresses, raw material is expended in the form of blades and debitage. As a core is reduced in size, so too are the subsequent detachments. As such, later stages of core reduction may be expected to produce smaller blades than initial or early sequences of reduction. However, since blade length is driven by initial raw material size, early stage blades are not necessarily long.

Collins (1999a) creates a six stage classificatory system that enables specific stages of Clovis blade manufacture to be interpreted based upon a series of technological attributes (Table 2). These stages are described in detail below. Blades detached during initial core preparation include those in which the exterior face is predominately covered with cortex. These are referred to as primary blades (Collins 1999a) and represent the initial stage in blade manufacture.

The exterior surfaces of primary blades are usually completely covered in cortex, making them difficult to distinguish from cortical flakes. However, a number of other attributes such as platform angle, lateral margin form, bulb prominence and proximal to distal skewness may be used to distinguish primary blades from cortical flakes. According to Collins, primary blades have large diffuse bulbs and large platform remnants (Collins 1999a; Dickens 2005).

Secondary blades exhibit some cortex on the exterior surface, while displaying evidence of at least one previous blade removal. Prepared ridges and irregular lateral margins also characterize secondary blades. Collins defines subsequent stages in order of progression to include more regular, moderately regular, regular and very regular blades, and basing classification qualitatively to the form of the lateral margins (Collins 1999a). According to Collins (1999a), more regular blades exhibit minimal cortex, while ensuing stages display no cortex, but with increasing curvature and number of removal scars. For the current analysis, blades are classified as either parallel or irregular. Specific characteristics of blades struck at different stages of the reduction process are illustrated in Figure 15.

Reduction Sequence and Modeling Technological Organization

Assessing the extent to which lithic reduction and lithic activities occur at a given site can lead to inferences regarding human behavior, and ultimately lead to the formation of models concerning technological organization and site function (Carr and Bradbury 2001). For instance, some lithic assemblages are composed of material associated with only the early stages of blade production, (cortical blades and lack of formalized cores). At other sites, assemblages exhibit the full spectrum of blade production including interior blades, preformed cores and blade core tops.

A key question then becomes: What function does a particular site serve in the overall pattern of lithic production in a given region? Is the ultimate goal of onsite reduction to produce blades (tool production)? Alternatively, is reduction geared toward the production of roughed out blade cores that may be transported offsite, to be utilized for blade production as need arises? In order to answer such questions, this analysis examines specific attributes that can differentiate between blade (tool) production and incidental flake production, and the sequential stages involved in each (Carr and Brad-bury 2001). I present a more in-depth discussion of such attributes in Chapter V.

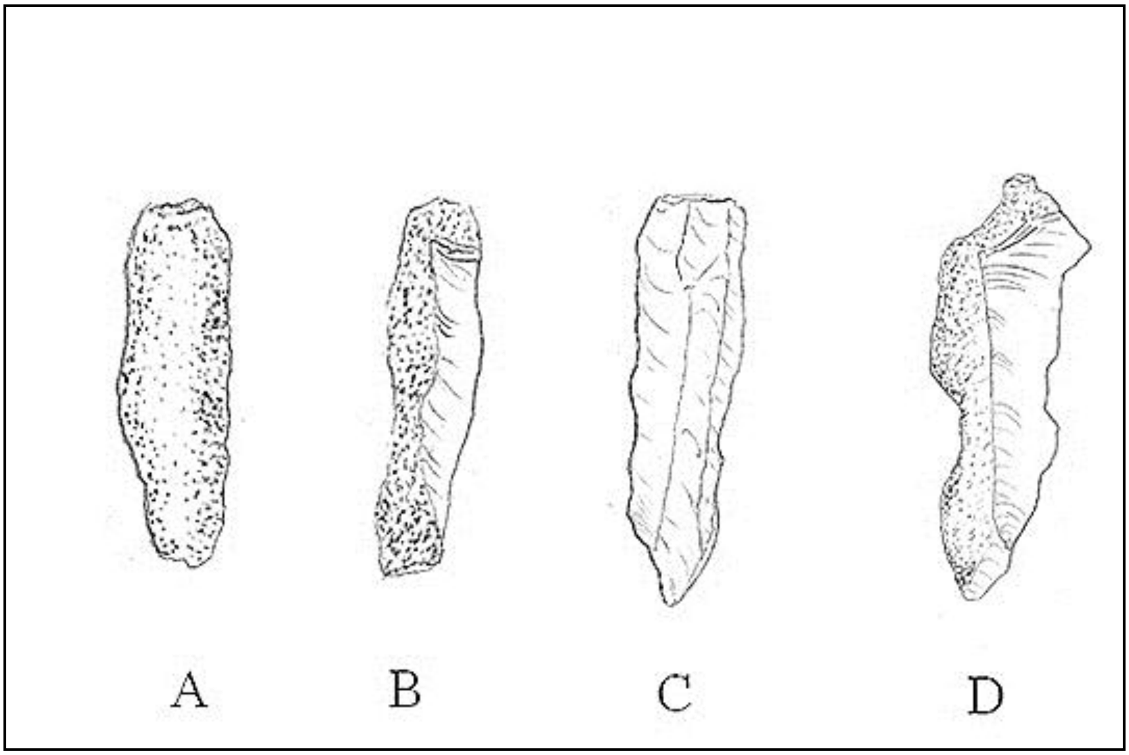


Figure 15. Blades from different stages in the manufacture trajectory. A: Parallel primary decortication blade, B: Parallel secondary reduction blade, C: Parallel interior reduction blade, and D: Irregular secondary reduction blade.

Table 2. Six stage blade classificatory system created by Michael Collins (1999a).

Stage	Class	Characteristic Attributes with Soft Hammer
I	Primary blades	Natural exterior surfaces, large bulb and platforms,
II	Secondary blades	One to two scars, large bulbs, slight curvature.
III	More regular blades	Multiple prior scars, large bulbs, little curvature.
IV	Moderately regular	Multiple prior scars, flat bulbs, moderate curvature.
V	Regular blades	Multiple prior scars, flat bulbs, strong curvature.
VI	Very regular blades	Multiple prior scars, flat bulbs, strong curvature.

Blade Research

In this section the archaeological evidence of blades and blade technology is examined. A brief history of blade research is provided, beginning with the earliest documented evidence of blades. Subsequently the current knowledge of Clovis blade technology is examined, with an emphasis given to Southeastern assemblages. This Chapter is closed with a discussion on issues pertinent to past and present blade research.

Archaeological Evidence from the Old World

The earliest precursor of a blade technology comes from the Middle Paleolithic of Central Asia about 200,000 years BP. During this period, detachments were struck from the lateral margin of a discoidal core, with fracture occurring along the convex face (Bar Yosef and Kuhn 1999: 323). This technique is known as Levallois. Objective pieces selected for reduction were given little preparation prior to detachment. The Levallois technique was a precursor of methods later used to strike longer, thinner blades from prismatic cores (Fiedel 2000:41).

During the upper Paleolithic in Europe, methods of blade production became more technologically efficient. During this period, blades were struck from platforms, prepared at one end of the core. Blades were struck in a series, along the core face. Blades struck in this manner were prismatic, and it was possible to strike numerous blades from a single core, obtaining maximum blade-length while using relatively little raw material in the process. (But see Bar Yosef and Kuhn for an alternative view point). Such production methods are very similar to those evident at some North American Clovis blade assemblages.

Clovis Blade Technology at the Topper Site

Archaeological Evidence from the New World

In the New World, evidence of blade production is found in archaeological assemblages that may predate as well as post-date Clovis. Blade industries in presumed pre-Clovis contexts have been identified at several sites, including Cactus Hill in Virginia (McAvoy 1992), as well as at Topper (Goodyear and Steffy 2003). These assemblages however are typically dominated by small blade production, as opposed to the larger blades frequently found in Clovis contexts.

In North America, and in some cases South America, blades have been reported from a number of Clovis-aged sites, and across various regions (Collins 1999a; Green 1963; Kilby 2008). Yet Clovis blades and blade technology have only recently become a focus of attention in lithic studies of Clovis assemblages (Collins 1999a; Dickens 2005). Recent blade research has placed much emphasis on distinguishing Clovis blades from those recovered from assemblages that are temporally discrete. Such analysis has centered on the identification of specific attributes that characterize blades recovered in association with other known Clovis tool types, specifically fluted projectile points. Unlike fluted preforms and projectile points, blades are not temporally diagnostic of any single culture. Consequently, for blades to be classified as a component of the Clovis toolkit, some studies have suggested that they be found not only in assemblages with fluted points, but also in stratified context with such artifacts (Collins 1999a).

The earliest description of a Clovis blade assemblage was that of a cache of 17 blades recovered in 1962 from Blackwater Locality No. 1 (Green 1963). Prior to this discovery, blades and blade fragments had been identified at other sites, notably Lehner (Haury et al. 1959), but it was only with the discovery at Blackwater Draw that blades, as a tool type, were recognized as a part of the Clovis lithic tool production industry. Further research at similar sites yielded additional blades and blade assemblages. These assemblages were often either caches or were associated with the remains of proboscideans and other Pleistocene age animals (Collins 1999a). Excavations at Murray Springs and Lehner in Arizona during the late 1960s and early 1970s produced evidence of blades in such contexts (Haynes and Huckell 2007). Additional blade discoveries such as at Carson Conn Short (Broster and Norton 1996) and Nuckolls (Ellerbusch 2004) in Tennessee further supported the notion that blades were a component of the Clovis lithic toolkit.

Probably the most extensive analysis of blades and blade technology undertaken was that conducted by Michael Collins. Collins (1999a) conducted a comparative analysis of blades from a number of sites to establish cultural affinity. Because blades occur in assemblages that postdate Clovis, a method was needed that could distinguish Clovis-aged blades from those representative of other cultures and in the absence of independent dating control (Meltzer and Cooper 2006: 127). Collins response to this issue was to examine and compare blades of known Clovis origin, to those of unknown or probable Clovis origin, observing the extent of similarity among specific morphometric and technological attributes. "Plots on triangular graphs of the ratios of blade length, width, and thickness to the sum of each measure were created as a method to determine cultural affinity" (Collins 1999a; Meltzer and Cooper 2006: 127). Through a comparative analysis of assemblages from twenty-four sites, Collins found blades to vary extensively, yet share a number of attributes in common (Collins 1999a) (Figure 16). Based on his analysis, Collins concludes that Clovis blades generally have flat or no bulbs of force, small platform remnants, and curved longitudinal cross sections (Collins 1999a). Furthermore, Clovis blades are often greater than 100mm in length, but no less than 50mm. Blades from later temporal periods were found to be smaller in length.

Collins found these characteristics to be diagnostic of Clovis blade production. However, it is possible that some attributes may reflect regional differences in raw material properties. Since Collins study, additional analysis has been undertaken in an attempt to refine, and discover new methods of blade identification. One such study examined the blade assemblage from 5GN149, a lithic workshop in the Gunnison Basin, Colorado. In this study, Meltzer and Cooper found that blades of possible Clovis origin can be identified based solely upon the metrical variable of blade length (Meltzer and Cooper 2006). In closing, they assert that interpretations should be made based upon quantitative techniques as opposed to those based upon visual, qualitative assessments (Meltzer and Cooper 2006: 127). A majority of the blades examined by Collins were recovered from assemblages located in the Plains and South Central United States, with the exception of the Adams site in Kentucky. As such, the possibility for variation to exist in blade technologies across and within different

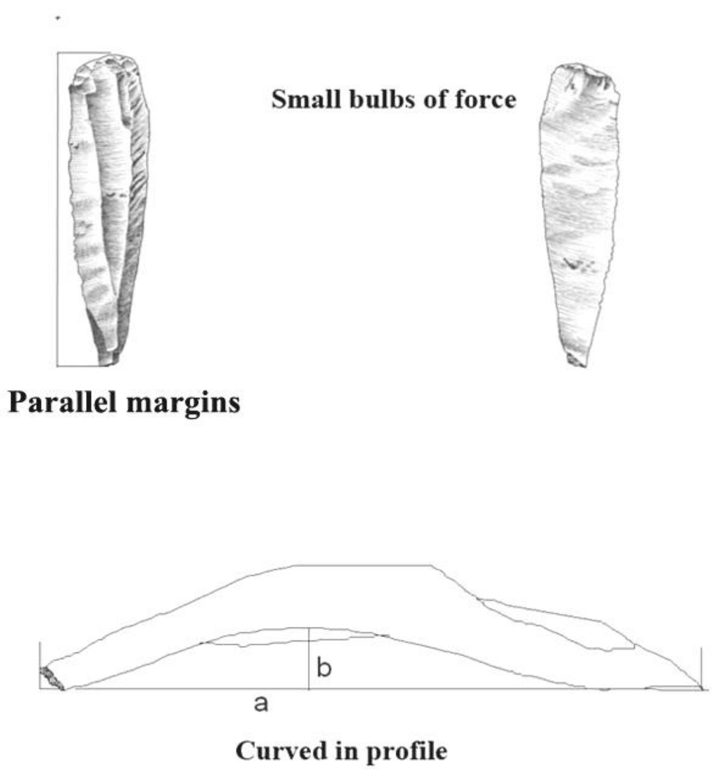


Figure 16. Attributes of Clovis blades as found by Collins 1999a.

geographical regions remains largely unknown based upon the limited assemblages examined. In a preliminary report on the discovery of blades at Topper, Goodyear observes such artifacts to exhibit relatively straight longitudinal profiles, wide platform remnants, and to often display evidence of heavy grinding (Goodyear and Steffy 2005). Blades at Topper therefore would appear to differ in at least some of the attribute states that Collins concluded are diagnostic indicators of Clovis (Collins 1999a). The present analysis will address this issue. It will investigate if there exists any regional diversity in strategies of Clovis blade production, and possibly technological organization. In contrast, variation in blade attributes recovered at manufacture locales could imply that the complete blades best suited for specific tasks were selected and carried away for use elsewhere (Collins 1999a:182). Such blades may also exhibit modification. If this is true, the attributes commonly present on blades recovered away from the source should reflect those most desirable to Clovis groups.

Prior to Collins analysis, research dedicated to the analysis of Clovis blades and blade technology suffered from several issues. First, the regional distribution of blades varied significantly. While blades and evidence of blade manufacture are present at Clovis sites in some regions, notably the Southeast and Southwest U.S., in other regions blades are found to be less common, if present at all. Blades are rarely found at Clovis sites in the Northeast, and occurrences are sparse throughout the West (Collins 1999a:4). Blade assemblages are more common in the Southeast, yet due to a lack in preserved faunal remains often associated with Clovis assemblages, combined with limited organic material for radiocarbon dates, it is not possible to assign these assemblages as Clovis in origin with certainty. The general lack of blades from the Northeast is an enigma, as one would expect tools such as blades, (a tool form that could have served multifunctional tasks) to also serve the acquisition of a variety of subsistence requirements. Moreover, while the role of bifaces in Clovis technological organization has been widely published (Smallwood 2010; Boldurian 1991; Goodyear 1979; Kelly and Todd 1988), the role of Clovis blade cores in similar context has generally been overlooked, and therefore not well recognized. (Rasic and Andrefsky 2001:62). According to Rasic and Andrefsky (2001) studies involving blade core technology tend to stress production techniques and tool function, as opposed to how blade core reduction strategies relate to issues of technological organization and mobility (Rasic and Andrefsky 2001:62). In addition to regional discrepancies in the distribution of blades, other problems involved poor documentation. For example, early publications of some sites lack mention of the presence of tools made on blades (Collins 1999a:148). Other reports contain contradictory accounts and misidentifications. For example, Collins suggests that at the Graham Cave site in Missouri, early descriptions referred to blades as knives (Logan 1952). Later publications make no mention of these specimens (Collins 1999a:148). At other sites, blade assemblages were reported, yet these often did not meet the technological definition of a blade (Collins 1999a). Such discrepancies in published accounts of blade assemblages led to a misleading and erroneous understanding of Clovis blade technology.

Archaeological Evidence from the Southeast

The southeastern United States is one region where blades and evidence of blade manufacture are prevalent (Table 3). In this

Table 3. Selected Southeastern Clovis blade assemblages and interpreted site function. Habitation refers to long term occupation, whereas Base camp refers to short term or temporary occupation

Big Pine Tree	Quarry Related Lithic Manufacture Base camp	(Goodyear 1992)
CCS*	Quarry Related Lithic Manufacture Base camp	(Broster and Norton 1996)
Nuckolls	Lithic Manufacture / Habitation	(Ellerbusch 2004)
Sinclair	Quarry Related Lithic Reduction	(Broster and Norton 2009)
Wells Creek	Lithic Manufacture / Habitation	(Dragoo 1973)
Williamson	Quarry Related Lithic Manufacture Base camp	(McCary 1951, 1975)
Adams	Lithic Manufacture / Habitation	(Sanders 1990)
Ezell	Lithic Manufacture / Habitation	(Yahnig 2004)
Roeder	Lithic Manufacture / Habitation	(Yahnig 2004)

region, blades have been identified at a number of sites, and are often associated with quarries, workshops, habitation locales, and as isolated finds, as opposed to caches and kill sites that are more prevalent throughout the West. Apart from Topper, Southeastern sites with identified blade assemblages include Carson Conn Short (Broster and Norton 1996; Stanford et al. 2006) Nuckolls (Ellerbusch 2004a, 2004b), Sinclair (Broster and Norton 2009), and Wells Creek Crater (Dragoo 1973) in Tennessee, and Williamson (McCary) and Cactus Hill in Virginia (McAvoy 1992). Moreover, Yahnig (2004) describes at least four Clovis sites in Christian County, Kentucky (The Little River Clovis Complex) as having a blade and blade core industry. Such sites include Adams (Sanders1990), Boyd-Ledford, Roeder, and Ezell, and have assemblages comprised of both blade as well as biface technologies (Yahnig 2004). Collins mentions Stanfield-Worley in Alabama, and Wells Creek in Tennessee as assemblages with a "robust blade technology" (Collins 1999a:148). Furthermore, Sanders suggests the Quad and Pine Tree sites in Alabama as assemblages containing a probable Clovis blade and blade core industry (Sanders 1990:52-67).
(Sanders1990), Boyd-Ledford, Roeder, and Ezell, and have assemblages comprised of both blade as well as biface technologies (Yahnig 2004). Collins mentions Stanfield-Worley in Alabama, and Wells Creek in Tennessee as assemblages with a "robust blade technology" (Collins 1999a:148). Furthermore, Sanders suggests the Quad and Pine Tree sites in Alabama as assemblages containing a probable Clovis blade and blade core industry (Sanders 1990:52-67).

A number of Southeastern sites that contain prismatic blades and evidence of blade manufacture have been identified as quarry related/lithic manufacture areas. The lithic assemblages at these sites are dominated by the presence of locally available high quality materials. High quality materials suitable for the production of stone tools are typically cryptocrystalline, having isotropic properties that allow for the detachment of conchoidal flakes.

According to Broster and Norton (1996), Carson Conn Short is not only a quarry, but also served as a lithic manufacture and base camp site. At Carson Conn Short, the lithic raw material source utilized in the production of blades is no more than 250 meters from any point of habitation. Furthermore, blades and blade cores recovered at the site are found to represent the entire trajectory in the process of blade manufacture (Broster and Norton 1996:4). Other sites (Wells Creek Crater and Nuckolls) served strictly as lithic manufacture locales, where raw material, once extracted, was brought and reduced into tool form. Finally, sites such as the Sinclair in Tennessee were utilized as quarry-related lithic extraction areas, where raw material was initially reduced, only to be taken elsewhere in manageable forms for blade production would subsequently commence.

Similarly, quarry and quarry-related sites within the Savannah River Valley, apart from Topper have been found to contain evidence of prismatic blade manufacture. The Big Pine Tree site, approximately 1km upstream from Topper is one such example. Here, lithic debris in the form of tools and debitage from across the entire cultural sequence in the region has been recovered through excavations, as well as data recovery projects along the creek bank. Included within the recovered lithic assemblage are a number of large prismatic blades found in association with diagnostic fluted projectile points.

Though prismatic blades and blade technology appear to be a common occurrence in the Southeastern United States, several issues prove problematic for researchers interested in Clovis blade technology. First, there is a lack of sites that contain buried stratified deposits with blades in context with other known diagnostic Clovis artifacts. Blades are a common tool type utilized by a number of cultures that post-date, and in some cases may predate Clovis. While many regional assemblages may appear to share technological attributes similar to those that Collins finds to be common among Clovis blades, some sites in the region such as Adams are comprised only of surface assemblages, and are possibly in a secondary context. At other sites, blades appearing to be Clovis in origin, are found in stratigraphic context with temporally later diagnostic artifacts. At Carson-Conn-Short for example, prismatic blades have been recovered from strata both above and within that containing fluted projectile points. Though these reductive approaches are stated as the "predominant production activities" occurring at the site, relating cultural affinity to the blade assemblage is difficult (Broster and Norton 1996; Stanford et al. 2006:4). It would appear that a lack of discretely buried stratified sites in the region is a major obstacle in defining Clovis blade assemblages. At Topper however, a recent study by Miller found there to exist in situ Clovis deposits from the Hillside portion of the site (Miller 2007). This discovery makes possible comparisons of a known Clovis blade assemblage to those in the region that may or may not be stratigraphically intact. Results may inform about, and lead to a broader understanding of Clovis blade technology in the region.

Issues Concerning Blade Research

The technical definition of a blade is of fundamental importance to archaeologists studying blade technology. Prehistorians have proposed several definitions that attempt to identify specific attributes, or combination of attributes, that constitute a blade. While a flake is defined as "a portion of rock removed from an objective piece through percussion or pressure" (Andrefsky 1998:xxii), Francois Bordes (1961) defines a blade as any flake twice as long as it is wide. By this definition, variations in length to width ratio differentiate blades from other flakes. This definition is problematic in making distinctions between a blade technology, and the incidental production of blade-like flakes involved in another reductive approach. While this definition does describe the morphologic characteristics of a blade, it fails to provide the technological attributes associated with a specific manufacturing process. Blade–like flakes can occur in many assemblages, however, the term blade should be reserved to describe the product of a systematic reductive technique and one that involves a deliberate, planned line of attack from design concept to finished product (White et al 1963).

Bifaces and blades are often found together in Clovis lithic assemblages, and bifacial thinning flakes, as well as bipolar cores are often misidentified as blades and blade cores (Parry 1994:87). Callahan (1979:53) suggests however that although bifacial flakes may have longitudinal ridges and prepared platforms, and are often twice as long as they are wide, optimum flakes detached from cores in Clovis biface production should not be misidentified as prismatic blades.

Crabtree (1972) adds to the definition of a blade to include those specialized elongated flakes with parallel to sub-parallel edges, its length equal to at least twice its width, with one or more longitudinal crests or ridges on the exterior face (Crabtree 1972) Furthermore, there should exist two or more scars of previously removed blades accompanied by force lines and compression rings indicating applied force in the direction of blade attachment" (Crabtree 1972). Other criteria used to define a blade include the existence of wide angle platform, scars that originate from a single platform, (Johnson 1989) and frequently triangular or trapezoidal cross sections (Parry 1994).

Another concern of blade research involves size. While blades vary little in width and thickness, lengths often do. Archaeologists refer to small blades as micro blades or bladelets, and there is a lack of agreement and ambiguity in the distinction between small blade variants and larger blades frequent among Clovis assemblages. Tixier defines a micro blade as 30mm in length or less, and 10mm or less in width (Tixier 1963:35-39). According to Tixier, variations in width should be the determining factor in assigning a specimen the designation of a blade. In his research, Tixier uses ratios of length and width to distinguish between blades, bladelets, and blade-like flakes, and these ratios are subsequently used to assign cultural affinity. However, the lack of technological attributes used for differentiating these artifact forms makes such definitions questionable.

In opposition to Tixier, Crabtree (1968), and later Collins (1999a) use 50mm as a determining measure in distinguishing micro blades from blades. It should be noted that Collins uses this limit to distinguish Clovis from other blade assemblages. According to Collins, blades recovered in Clovis assemblages are generally greater than 100mm in length, but can range as small as 50mm (Collins 1999a). In addition to large blades, there is evidence at some Clovis sites of blades that are much smaller in size, yet still fit the technological definition of a blade (Collins and Lohse 2004). One must use caution when referring to such blades as micro blades, however. According to Collins, this distinction should be reserved for a micro blade technology, complete with micro cores. Small blades recovered in Clovis contexts often bear little resemblance to micro blade technologies (Collins and Lohse 2004). One must use caution when referring to such blades as micro blades, however. According to Collins, this distinction should be reserved for a micro blade technology, complete with micro cores. Small blades recovered in Clovis contexts often bear little resemblance to micro blade technologies (Collins and Lohse 2004).

A micro blade technology should exhibit evidence of the (micro) cores from which these blades were struck. At most Clovis sites, there is no such evidence of micro blade cores. This finding implies that specimens identified as micro blades are actually being struck from the same cores from which larger blades were previously struck. To this regard, blade size is a factor of both raw material constraints as well as the specific stages represented in the reduction sequence, as opposed to a systematic micro blade industry.

A number of questions may be formed regarding blade research at Topper. First, are the blades identified at Topper representative of technological blade manufacture, or the result of a biface reductive approach? Second, is there evidence for variation in blade attributes when the Topper assemblage is compared to other site assemblages, and from isolated finds from the region? More significantly, what could such variation mean in terms of how Clovis groups organized their lithic technology across space? Finally, by recognizing specific attributes that are most frequently found on Clovis blades, it is possible to form a better understanding of the conceptual ideas that were implemented in the production of a specific tool design.

For the purpose of this analysis, blades are defined as any lithic detachment with two or more parallel removal scars on the exterior surface originating from the same plane or surface. Attributes on complete blades include a striking platform remnant on one end of the blade from which at least two parallel blades were detached, and platform angles of 60 degrees or greater. Moreover, these blades should have parallel lateral margins, triangular to trapezoidal cross sections, thicker distal ends than blade proximal ends, and bulbs of force that are diffuse. While blades are often twice as long as they are wide, this attribute does not define a technological blade, and will not be included for use as such in the current study. Certain attributes characteristic of Clovis blades, for example, may no longer be present on broken blades or blade segments that may once have fit this definition.

Chapter IV

REGIONAL CONTEXT AND SITE SETTING

This chapter provides the context and site setting for the Topper Site. A brief overview of archaeological work conducted in the region is provided, with an emphasis given to the central Savannah River Valley. Recent models are presented that have been developed that attempt interpretations of such research. The Topper site setting is discussed in detail, accentuating the past and present environmental conditions. Finally a review of the excavation history at the Topper Site is offered, providing a description of the lithic assemblage.

Regional Context

Although it was not universally accepted at the time, identification of Paleoindian occupation within the southeastern United States pre-dates that of the discovery of the Folsom culture in New Mexico in 1927. Sites linking humans with extinct fauna, for example, have been noted as early as the mid-19th century at sites such as Big Bone Lick, Kentucky, and at Kimmswick, Missouri (Tankersley 1985). Obtaining dates for these sites relied on relative dating that sought to identify the stratigraphic position of projectile points associated with faunal remains. These sites were sparse, however, and good geological contexts, especially with well-established assemblages, were difficult to locate.

By the mid-20th century, further excavations established deeply stratified sites in the region, and with the aid of new dating techniques, contributed to a much broader awareness of Paleoindian occupations within the Southeast. By the 1960s it was apparent that the region possessed some of the densest assemblages of fluted preforms and points anywhere in the Americas (Anderson et al. 1996:3). In recent years, with the increasing discovery of greater numbers of diversified Clovis assemblages, it has become increasingly apparent that the archaeological record of the Southeast consists of much more than the isolated projectile point discovery or "light artifact scatter" (Anderson 1996:55). Ensuing research in the region has focused on the development of models that seek to explain patterns of Paleoindian settlement, life-ways, mobility patterns and subsistence adaptation (Anderson and Sassaman 1996a). These models were largely based upon physiographic, environmental and ecological factors that may have influenced group decisions and behavior.

One such model was developed by Gardner, and known as the Flint Run Lithic Determinism model. It proposes that hunter gatherer settlement was "tethered" to areas rich in lithic resources such as quarries (Gardner 1974, 1977, 1983, 1989). According to this model Paleoindians set up base camps near sources of lithic raw material, with groups of seasonal foraging excursions spreading out across the landscape (Anderson and Sassaman 1996b: 23–24). This strategy stresses a relatively low degree of population mobility, as opposed to high movement of populations across vast areas of the landscape (Daniel and Wisenbaker 1989). This model is found to work well where lithic resources are localized, but in physiographic regions of abundant lithic materials, there would be little need to justify a return to the same source. If the tools that were manufactured at a quarry were transported some distance off-site for use, what need would there be to return to the same source to replenish exhausted tools, if other sufficient sources could be accessed closer to the area of tool exhaustion?

Similar to Gardner's Flint Run Determinism model, Goodyear (1979) asserts that the location of high quality cryptocrystalline chert sources across the landscape played a significant role in population settlement subsistence patterns. The location of raw material is stable, and therefore, predictable; the occurrence and availability of food is not (Goodyear 1979). Before people could manufacture stone tools, they needed to know where on the landscape to obtain the suitable and necessary raw materials for their production. Just as well, there was a need to have these materials at hand for daily subsistence. Because it was not always possible to attract food resources to the areas of raw material procurement, an adaptive strategy was necessary that would allow for sufficient production and transport of stone, and at least cost, for daily subsistence purposes. While he supports Gardner's claim that raw material access played a critical role in determining the settlement patterns of Paleoindians, Goodyear contends that higher residential mobility was probable, and lithic raw material procurement was an "embedded" practice, as opposed to the "tethering" practice proposed by Gardner (Miller 2007:7).

Anderson's (1990) diachronic model of human settlement in the Southeast postulates that groups should opt to occupy resource rich areas when encountered. According to this colonization model, such locales served as "staging areas that facilitated settlement of the larger region" (Anderson 1996:50). As chert quarries likely provided the necessary material to produce stone tools, these locales would have been prime areas around which to base settlements, provisioning camps with raw material. However, in some areas, quarries may not always be evident on a virgin landscape.

In addition to the models listed above, artifact distribution studies (Michie 1977; Charles 1981) conducted along the central Savannah River Valley have revealed a close affiliation between the density of isolated projectile points and the sources of high quality cryptocrystalline chert (United States Department of the Interior [USDI, NPS] 1985). Moreover, additional research has emphasized lithic raw material sourcing (Goodyear and Charles 1984; Upchurch 1984). In a study geared to locate sources of suitable raw material, Goodyear and Charles (1984) located 13 chert outcroppings along the banks of the Savannah River. Distribution and lithic raw material sourcing studies have helped archaeologists identify material resources, and ascertain patterns of Paleoindian mobility (Anderson 2005:34; Anderson et al. 2010).

Apart from distributional studies of stone, additional models have sought to relate occurrences of Paleoindian sites to other important resources such as water. During the late Pleistocene, the climate was much cooler than today, and river drainages may have provided a haven for bands of Paleoindians retreating south from colder, less hospitable environments. All cultures require water, for sustenance and the majority of sites producing Clovis aged artifacts in the Southeast are situated on hilltops or ridges overlooking some type of water source (Gardner 1977:62; Daniel and Wisenbaker 1989:140). Though beyond the scope of the present analysis, the Savannah River, flowing from northwest to southeast, along the South Carolina-Georgia border is a likely locale to test such a model. It would have provided ample biotic resources for prehistoric peoples traversing the region. Upland bluffs, often containing chert outcrops overlook the river. The entrenchment of the river over time, due in part to lower sea levels than today, encouraged terrace formation and landform stability, and combined with locally available high quality chert outcroppings, provided prime locations for prehistoric use and settlement.

Site Setting

The behavior of Paleoindian inhabitants at Topper was likely influenced by environmental factors such as topography, soils, climate, and the availability of material resources (Sanders 1990:3). As such, an overview of modern and prehistoric environmental conditions in the region, including information specific to the local environment at Topper, is necessary in order to obtain a better understanding of past use of the site.

South Carolina is divided into four physiographic zones. These regions include Mountain, Piedmont, Sand hill, and Coastal Plain. The Topper site is located in Eastern Allendale County, South Carolina, and is adjacent to the Savannah River, which now forms the border with Georgia (Figure 17). This region occupies a portion of west-central South Carolina, and lies within the Middle Coastal Plain physiographic province.

The Topper site is one of a number of terrestrial and submerged prehistoric chert quarries identified on the property of the Clarient Corporation, formerly owned by the Sandoz corporation (Goodyear et al. 2007). The site occupies multiple topographic features of the landscape, including the river, an alluvial terrace formed by the entrenchment of the river, and a hilltop above the terrace that is part of the Coastal Plains uplands (Goodyear et al. 2007; Miller 2007, 2010).

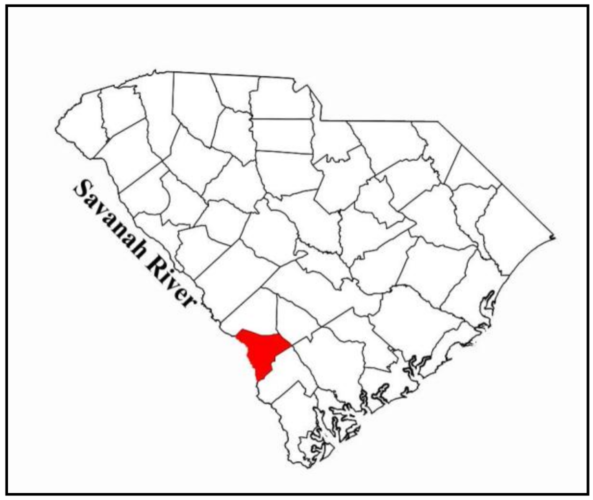


Figure 17.

Map of South Carolina with Allendale County highlighted.

Owing to the variation in topography, there exists a diversity of local flora and fauna in the region. In addition, several major soils are found to exist in this region, though at Topper, most areas are composed of sand overlying sandy clay loam.

A chert outcrop is situated between the alluvial terrace and hilltop portion of the site. This outcrop is exposed as a result of erosion, and as a result of its use as a prehistoric quarry. This particular outcrop is defined as "a Tertiary-aged chert, belonging to the Flint River Formation, and is classified as a silicified grainstone" (Upchurch 1984). Chert outcrops of this particular formation are thought to stretch northeast from Florida, across the Coastal Plain of Georgia and into the central Savannah River Valley of South Carolina, terminating near Allendale County. Exposed outcrops at Topper are nodular in form, and "nodule maximum diameters range in size from 300-500 mm" (Smallwood 2010; Goodyear personal communication) According to Smallwood, nodules often have "voids and flaws of

Figure 18. Chert outcrop exposed as nodules from the hillside portion of the Topper Site

cortical-like material that have never silicified" (Smallwood 2010) (Figure 18).

Additional sources of such material were also available as cobbles from the riverbed. The chert in this region is often referred to as Allendale, (the county of its origin) and is described as a "yellow, brown, waxy homogenous chert" (Upchurch 1984:15). This material is a key source of variable quality chert in the region, and is limited to the surrounding counties, primarily within a few miles of the river (USDI, NPS 1985). Large specimens greater than 500 mm in diameter may not have been available in abundance at Topper, thus restricting the capability of prehistoric knappers to produce lithic tools of sufficient size and shape. Initial surveys of the area (Goodyear and Charles 1984) resulted in the discovery of no primary habitation sites, as defined by the relative absence of sites with large quantities working tools This discovery suggests that the principal use of the area was related to raw material procurement and subsistence activities required to short-term use of lithic extraction areas.

Excavation History

The Topper site (38AL23) was first recorded in 1973. In 1981 that a local landowner named David Topper noticed high concentrations of Allendale chert outcroppings above the second alluvial terrace along the East bank of the Savannah River. Topper brought this discovery to the attention of Dr. Albert Goodyear of the South Carolina Institute of Archaeology and Anthropology (SCIAA), who was interested

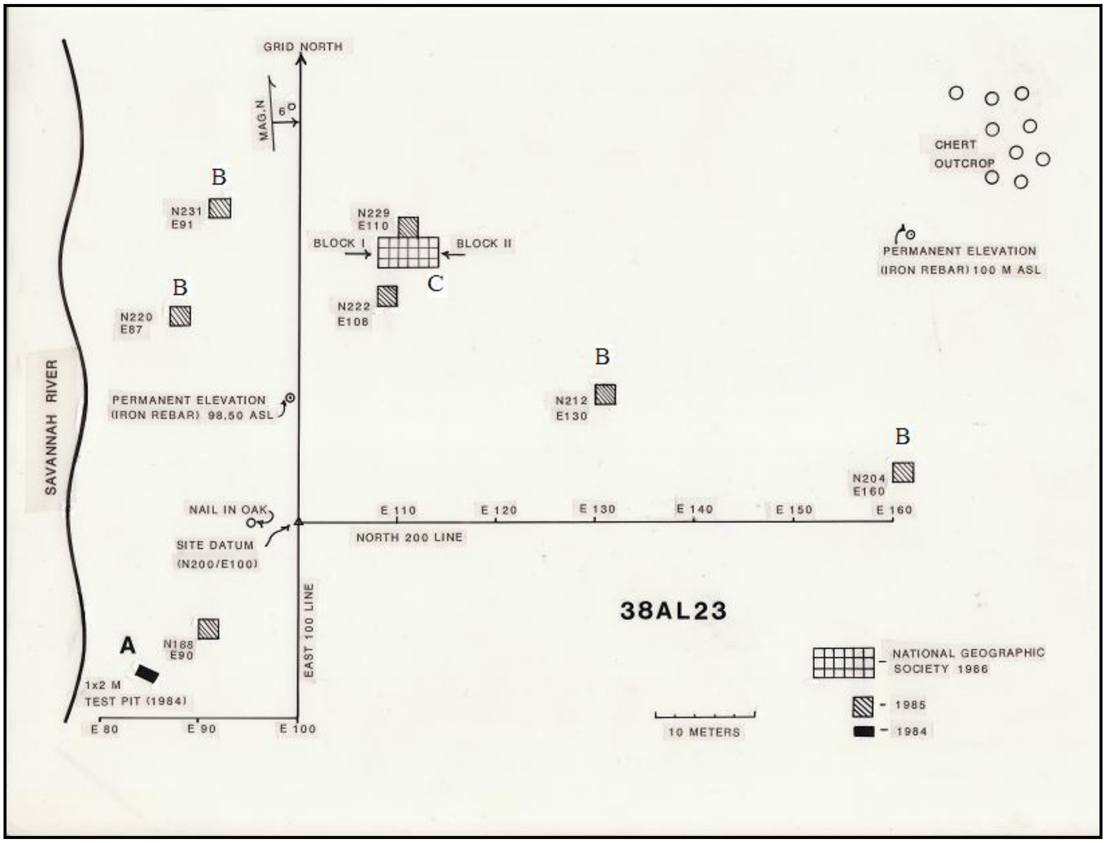


Figure 19. Topper site map of 1984 -1986 excavations. (Image courtesy of Al Goodyear).

in the outcropping's potential for containing evidence of prehistoric use. Dr. Goodyear, with the help of Tommy Charles, initiated a 1984 survey of the area, and identified evidence of quarrying at the outcrop.

Archaeological excavations at Topper have been conducted over a number of topographic features including a hilltop of the coastal plain landform, a "hillside slope" that contains a series of chert outcroppings, and an alluvial second terrace adjacent to the Savannah river (Goodyear2007:2). Initial testing at Topper was undertaken in 1984 under the direction of Albert Goodyear and SCIAA. This excavation consisted of a single 1x2 meter test pit (Figure 19 A) located on the alluvial terrace (Goodyear 1986:3).

Further testing was conducted in 1985 including the placement of seven 2x2 meter test units. At this time, a grid system was established at the site including a permanent datum and elevation markers (Goodyear 1986). The 1985 excavation resulted in the discovery of a possible Paleoindian presence at the site. In 1986, excavation at Topper continued with the aid of funding through the National Geographic Society. An additional 18 1x1 meter units (Figure 19 C) were meticulously excavated this season, revealing an assortment of cultural material spanning the entirety of cultural history (13,500 years) in the area. Though no diagnostic Clovis artifacts were recovered from in-situ stratified deposits, a single bifacially fluted preform was recovered on the surface approximately "40 meters from the excavation" area (Goodyear 1986:6).

The cultural sequence above the alluvial terrace at Topper includes a Mississippian component from 0-10 centimeters below surface, (cmbs), a Woodland component from 20-35cmbs, a Middle -to Late Archaic component consisting of large quantities of thermally altered chert from 35-50 cmbs, an Early Archaic component from 55-75 cmbs, and a Paleoindian component from 75-110 cmbs. Though no diagnostic Clovis artifacts were encountered at the time of the 1986 excavation, the discovery of numerous bifaces, unifaces, and utilized tools beneath strata containing side notched and Taylor points suggested a likely Clovis occupation at the site. Such deposits were buried at the base of C-horizon sands resulting from colluvial slope-wash originating from the hill-slope (Goodyear 2007).

Excavation on the terrace resumed in 1998 and has continued every year to the present (Goodyear 2007). In 1998, eight 2x2 meter test units were excavated, resulting in the discovery of additional lithic tools of probable Clovis age (Figure 20). These artifacts included a number of bifaces, fluted preforms, unifacial tools, and cores. Of note was the presence of what appeared to be large prismatic blades and cores found in association with the bifaces from the Paleoindian stratum.

Prior to 1998, all excavation at Topper had ceased at sterile sediment at the base of the Paleoindian levels. However, due to recent "pre-Clovis" discoveries at a number of sites, (notably Cactus Hill in Virginia, Monte Verde in Chile, and Meadowcroft in Pennsylvania), Dr. Goodyear decided to take each unit deeper in an effort to test for the presence of pre-Clovis remains at Topper. Approximately 1meter of sterile sediment was excavated beneath the Paleoindian levels. However, at two meters below the surface, Goodyear encountered what he believed to be a cultural component that consists of a "smashed core" technology (Goodyear 2005a). Possible artifacts recovered at these depths included small prismatic blades, cores, microlithic flake tools, and debitage resulting from their manufacture. While no diagnostic artifacts that could be reliably associated with any known culture from the region were identified at these depths, technological attributes present on many of the flakes (i.e., bulb of force, bulbar scar, platform remnant) would seem to suggest that they were formed by cultural rather than natural formation processes. However, skeptics argue that the proposed "pre-Clovis" assemblage at Topper may result from natural processes such as thermal fracturing, or through "physical fracturing resulting from stream flow" (Waters et al. 2009;1309). Stratigraphically, these materials were recovered below a "moderately well-developed Bw paleosol horizon that formed in colluvial deposits" and lies beneath the Clovis cultural levels (Waters et al. 2009:1308). Optically Stimulated Luminescence Dates obtained from the top of the proposed "pre-Clovis" deposits returned 15,200 year BP and 14,400 year BP respectively, suggesting a minimum date for the deposits (Waters et al. 2009). Excavations at the "pre-Clovis" levels in this area have continued each year since 1998.

Two separate excavations conducted from 2002-2004 have identified the presence of additional Clovis artifacts at the site. In 2002, along the terrace between N282 and N294, and E132 and E140, a stratigraphically discrete" working floor containing a fluted Clovis point base, a Clovis point tip, unifaces, and a number of what appear to be large blades was encountered at depths from 80 to 100 cmbs (Goodyear 2007). An OSL date taken from sediment recovered from the Clovis strata

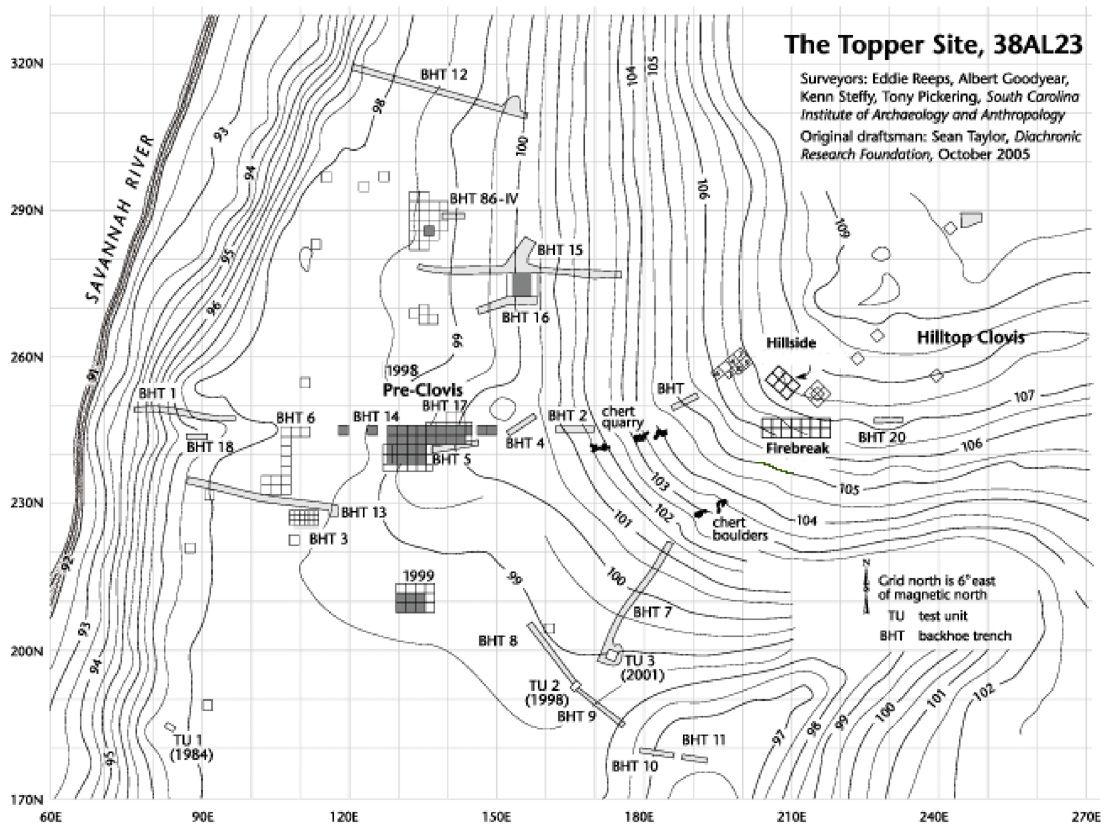


Figure 20. Map of Topper Site map showing excavations along the alluvial terrace.

returned a date of 13,600ka (Goodyear and Steffy 2006). Likewise, in 2003 between N270 to N280 and E150 to E160 an “industrial floor” was encountered (Goodyear 2007). This floor was dominated by the presence of initial stage decortication and core reduction debris (Goodyear et al. 2007). Though excavation was conducted in this area below the Clovis deposits, no lithic artifacts were encountered in the deeper strata. It appears that the proposed pre-Clovis deposits are restricted to an area along the terrace, between the Savannah River and the base of the hillside slope.

Apart from excavations conducted atop and within the alluvial terrace, recent archaeological investigations have focused on cultural material encountered within colluvially deposited sediment atop a hill that overlooks the floodplain terrace.

In 2004, the appearance of artifacts eroding from a roadbed adjacent to the chert outcropping along the hill slope prompted the execution of a salvage excavation in this area. Prior excavations at Topper had focused on the alluvial terrace at the base of the outcropping, and until this time, the consideration of the hillside as containing intact buried Clovis deposits was only speculative. In 2004, salvage excavation included the placement of a total of four 2X2m test units, and two 1X2m units. This excavation yielded an assortment of artifacts commonly associated with the Clovis toolkit, including Clovis preforms and bifaces. However, this excavation was dominated by the presence of what appear to be blades and debitage resulting from the manufacture of blades. The location of these test units along the slope of the hillside, combined with the effects of erosion, has resulted in a much shallower context for Clovis lithic material in this area. As a result of deflation, more recent archaeological deposits may be mixed with Clovis, or erosion may have removed them entirely (Miller 2007). As such, though it is possible artifacts appearing as Clovis in origin may be recovered from the upper 20cm of sediment in this area, cultural affinity cannot be stated with certainty. Consequently, only lithic material recovered from sediments in excess of 30cm in depth is examined for the present analysis as Miller (2007) has provided evidence for stratigraphic integrity below these depths.

With the discovery of Clovis artifacts atop the hillside, it was decided to expand excavation in this area for the purpose of delineating the extent of Clovis presence at Topper. In 2005, and 2006 a 4X16m block excavation was undertaken along a firebreak that cuts across the Southern section of the hillside. This excavation removed sediment from an area $64m^2$ in size over a period of two seasons of fieldwork (Miller 2007). Because diagnostic artifacts had been recovered from multiple time periods at Topper, the primary goal of this excavation was to determine if there exists a "buried Clovis deposit", and to ascertain if the spatial array of artifacts had been preserved (Miller 2007:24). The results of this analysis indicate that the assemblage does exhibit vertical integrity, though there are three particular areas where bioturbation has served as a post-depositional agent (Miller 2007:112). A subsequent refit analysis of the lithic material recovered from this excavation revealed little evidence for vertical movement of the artifacts, further indicating integrity of Clovis deposits in this area (Miller 2007:182).

In 2006, it was decided that a 4X6 meter block excavation be placed approximately 3 meters to the north of the firebreak excavation. The goal of this block excavation was to establish whether similar spatial patterns exist when compared to the Clovis lithic material observed from the firebreak excavation. Excavation in this area has since produced additional Clovis material including one finished projectile point base, along with occasional broken bifaces that cross-mend. Vertical separation of such artifacts is usually within a few centimeters (Goodyear et al. 2007). A spatial analysis of the diagnostic Clovis bifaces and debitage recovered from the Clovis strata by Miller and Smallwood (2009) suggests that this area served the purpose of secondary and later stages of biface production, whereas the Southern firebreak was composed of lithic material resulting from initial and early stages in the sequence of biface production.

In 2007, a series of 2x2 meter test excavations were placed along an "upper firebreak" North of the 2006 4x6 meter block excavation. Here, test units were excavated to sterile strata in 2007, 2008, and 2009. Clovis diagnostic artifacts have been encountered in each of these test units buried in intact stratified deposits. In addition, a number of these test units also contain evidence of what appear to be

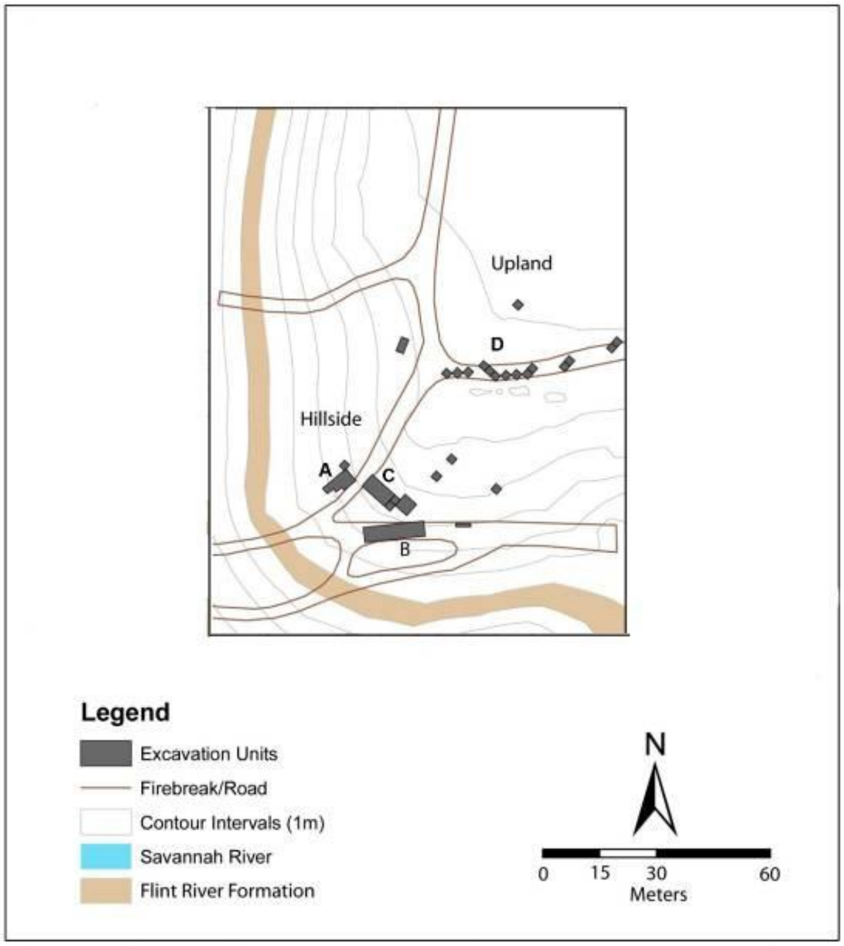


Figure 21. Site map showing hillside excavation at Topper. A; 2004 excavation, B; 2005 Firebreak excavation C; 2005-2007 block excavation; and D; 2008-2009 Northern Firebreak excavation. (Image Courtesy of D. Shane Miller).

blades, blade-like flakes, and debitage resulting from their manufacture. Excavation in this area continues to date.

The excavations listed above, along with the series of test excavations to the north, are the provenience from which the lithic samples for this analysis are selected. Figure 21 is a site map of the hillside, firebreak and hill top test units, illustrating the extent of excavation as of the 2009 field season At present, it is not yet known the extent to which Clovis deposits radiate to the north and east of the excavations previously undertaken along the hilltop. A ground penetrating radar survey conducted during the summer of 2008 revealed that such deposits likely extend some distance in these directions.

The 2005 firebreak excavation and the 2006 4x6 meter excavation, each use a unique and separate grid system. For the terrace excavation, an arbitrary datum was situated, with grid numbers starting at N100 E200. All excavation units at or along the terrace use this grid. The 2005 firebreak excavation block was oriented within the margins of the firebreak in an East West direction. The alignment of a grid that follows this configuration was placed for expediency purposes, and to salvage material that was being exposed through erosion on its western end (Goodyear et. al 2007).

Similarly, the 2004 salvage excavation was oriented along the margin of an access road adjacent to the chert outcropping. The alignment of this grid was also positioned in configuration with the western end of the roadbed. Units in this excavation were referred to as test units. The 2006 4x6 meter excavation was aligned to true north, and all future excavation at Topper on the hill-top will incorporate this grid system. While each of the block excavations listed above are aligned differently in regards to true north, each unit is labeled as to its southwest coordinate with a base unit size of 2x2m. The only exception to this are the two 1x2 meter units associated with the 2004 salvage. Subsequent and all future hillside excavations incorporate the grid system employed for the 4X6 meter excavation.

All excavation at Topper employs the use of arbitrary 10cm levels for the upper sediments. Arbitrary 5cm levels are introduced once excavation has reached 65cm in depth. Furthermore, each provenience is screened, employing $1/4^{th}$ inch mesh for 10cm arbitrary levels, and $1/8^{th}$ inch mesh for every 5cm arbitrary level. The use of one-sixteenth-inch screen mesh is employed when features are encountered.

The Topper Lithic Assemblage

Excavation at Topper has yielded an abundance of Clovis lithic material including bifaces, preforms, utilized flakes, prismatic blades or blade-like flakes, and debitage from the production of these tools (Figure 22). Such tools appear to represent at least three separate approaches of lithic reduction: biface production, blade manufacture, and generalized core/flake tool production. Bifaces include projectile point preforms and fluted projectile points. Preforms are found in various stages of reduction throughout the site, but few complete fluted Clovis points have been recovered (Goodyear and Steffy 2003; 2005). The majority of fluted preforms appear to be proximal and distal segments. To date, a total of four complete fluted preforms have been recovered. Other tools recovered through excavation include scrapers, gravers, denticulates and utilized flakes (Goodyear and Steffy 2003).

Debitage associated with biface manufacture and projectile point production includes overshot flakes, thinning flakes and channel flakes. Wedge and conical cores appear to be present, though the majority of cores are informal in morphology (Goodyear and Steffy 2005). Scrapers, as defined by morphology and a modified edge appear to be made on flakes, as opposed to blades. There is an abundance of utilized flakes in the assemblage. This discovery lends credence to the idea that the site may have been used as a short-term occupation locale, in addition to use as a quarry. In this scenario, utilized flake tools would have been employed for everyday purposes such as craft production, food processing, and other subsistence activities (Goodyear and Steffy 2005).

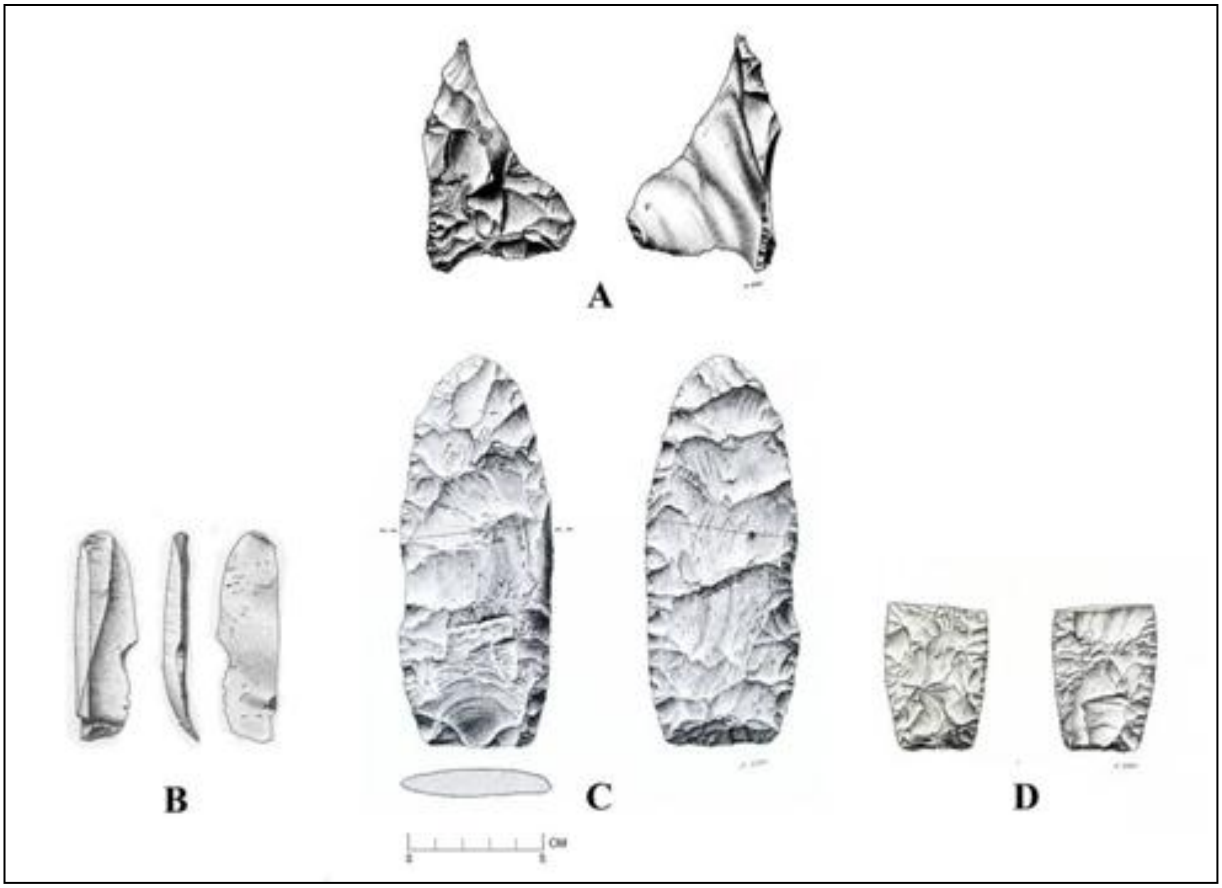


Figure 22. Clovis artifacts from the Topper Site. (Image credit Darby Erd, SCIAA).

Chapter V

RESEARCH DESIGN

This research specifically examines a sample of blades, cores, and debitage recovered through several seasons of excavation at the Topper Site from 1998-2008. Analysis of this material is geared toward providing a broader perspective of Clovis lithic technology within the central Savannah River Valley. Of interest are the design strategies employed in blade manufacture, stages observed in the reduction sequence, artifact attribute classification, and technological organization.

The sample of lithic material is taken from multiple test excavations carried out at the site. These include material recovered from both hillside and terrace portions of the site. Lithic material sampled from the hillside derives from a 4x6m block excavation conducted during the 2005 and 2006 field seasons, a 4x8m block excavation conducted during the 2005-2007 field seasons, and an ongoing block excavation that was initiated in 2007. Material sampled from the terrace excavation was taken from excavations conducted from 2002–2004. Finally, artifacts recovered from seven units placed adjacent to a roadbed, and just above the outcropping were sampled for this analysis.

A total of 472 blades, blade-like flakes, and blade segments have been identified from the Topper assemblage by archaeologists and volunteers over a number of field seasons. These artifacts were identified and recorded as such in the field without prior technological analysis. This research examines a sample of this material. However, this sample includes materials recovered from all areas of the site. In order to choose a sample of blades and blade-like flakes, the assemblage was initially separated according to cultural provenience. In some areas, particularly the 2004 roadside excavation, blades appearing to be Clovis were recovered from stratafrom10-30 cmbs. Though these artifacts may exhibit technological attributes of Clovis blades, they were recovered in questionable contexts. For this analysis, only those artifacts recovered from stratigraphically discrete deposits, associated with diagnostic Clovis artifacts are used. A thorough examination of the attributes found on the artifacts from this sample will allow formal descriptions of Clovis blade technology from the site. Table 4 presents the percentage of artifacts recovered from each area of the site.

After selecting the well-provenienced Clovis materials, specimen type, condition and length were determined. A number of artifacts at Topper that exhibit technological attributes of blades are much smaller than the definition of a Clovis blade as provided by Collins (1999a). These artifacts are referred to as bladelets, and are less than 30mm in length. The criteria listed above results in a total sample size of 333 blades, blade-like flakes, and blade segments, and 87 cores.

Because the sample of blades examined for this analysis were selected from an assemblage that has undergone pre-identification via numerous crew members who may not all share the same definition of what is and is not a blade, it is possible that some artifacts such as blade segments and fragments may have been missed. As such, the method of sampling chosen may have some impact on the variation present from the analysis of these blades. A review of the Clovis lithic assemblage recovered from Millers 2007 firebreak excavation may provide more context in terms of the larger

Table 4.

The percentage of proveniences represented by the for sample of blades that were examined for this analysis.

Area of Site	%Proveniences Sampled	%Blades .
Hill side	45.66	34.53
Terrace	39.13	29.13
Roadbed TU*	15.21	36.34

*Includes Test Units 4-7, 9-11.

lithic assemblage at the site. Accordingly Miller identified 33 bifaces, 44 cores, of which 40 are amorphous with little formal patterning, and 630 flakes. Three of the remaining cores were identified as blade cores (Miller 2007). There were four identified blades, only one of which had evidence of modification along an edge (Miller 2007:139). Other materials recovered among the piece plotted lithic artifacts include 36 modified flakes. Five of these were identified as end scrapers (Miller 2007). Finally, 13 other artifacts were found to have a modified edge that was straight yet did not fit the morphological definition of a blade. In addition to Millers analysis, Smallwood (2010) has examined the biface assemblage at the site, and has noted the recovery of 174 bifaces and biface fragments from the buried Clovis components on the Pleistocene terrace, hillside, and Coastal Plains uplands. In some cases, bifaces were found to have been produced on blade-like flakes or blade blanks (Smallwood 2010). The manufacture of bifaces and blades onsite likely led to the production of numerous debitage byproducts including broken blade-like flakes and blades. Due to their fragmented nature, the broken specimens may not have been initially recorded as blades. Taking this scenario into consideration, we may infer that the sampling strategy chosen for the present analysis is biased towards artifacts assumed to have been blades, and may not account for some broken pieces that exhibit attributes of technological blades yet are not twice as long as they are wide.

Blade Analysis

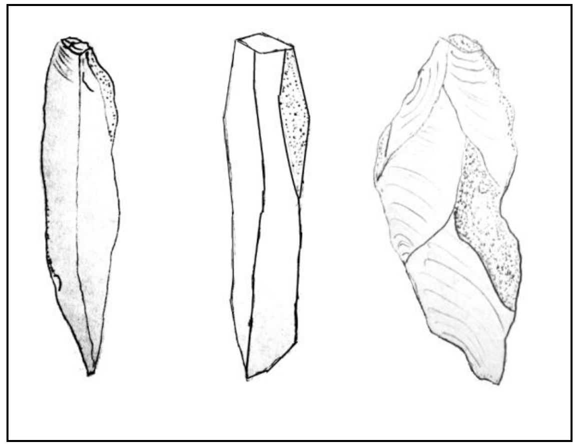
The analytic methods undertaken in this study are chosen to serve two purposes. The first is to establish the technological approaches employed that have resulted in the Clovis blade and blade-like flake assemblage at Topper. Are identified blades the product of a blade technology, or are they a byproduct of other approaches of lithic reduction? A second purpose is to determine the trajectory of blade manufacture, extent to which blades are produced onsite, and how such trajectories relate to larger issues of technological organization and settlement patterns. The methods employed are geared to assess technological approach based on artifact attribute classification.

In order to determine technological approaches, strategies, and trajectories of reduction employed in lithic manufacture, one must select the specific attributes to record. This may be problematic given that some lithic attributes are found to be common among multiple technological approaches, and that no single lithic attribute can accurately identify a specific technology (Carr and Bradbury 2001:134). For this reason, the current analysis examines a series of attributes that are consistently identifiable, and pertinent to this research. Multiple lines of evidence serve to reinforce conclusions or expose ambiguities among the assemblage (Carr and Bradbury 2001:129). Furthermore, the attributes utilized in this study allow for objective interpretations to be formed regarding modes involved in lithic tool manufacture, reduction sequence, and technological organization. In this section, blade attributes are discussed in detail, highlighting those most critical in making distinctions in reduction trajectory. These include attributes of the exterior and interior surfaces, as well as the platform remnant.

Blades are a product of prepared core reduction, whereas blade-like flakes may be produced through any type of core or biface reduction. As opposed to blades struck from prepared blade cores, blade-like flakes produced as a result of biface production vary greatly in size. Although the exterior surfaces of these flakes are characterized by two or more previous flake removals, blade-like flakes may be identified by multi-directional removal scars (Figure 23). Platform remnants of these flakes can be faceted or ground/abraded. Blade-like flakes produced through general flake core production result in large, and often wide flakes.

Attributes of the Interior and Exterior Surfaces

For this analysis, attributes consistent with prepared production include the presence of



A. B. C.
Figure 23.
Blades (A and B) and Blade-like flake C.

two or more parallel removal scars on the exterior surface that emanate from the same plane or margin, and in the same direction. These blades also have “relatively even, parallel lateral margins” (Collins 1999a:9; Collins et al. 2003:120). Where multiple scars are present, they are either unidirectional or bi-directional, but usually not multidirectional (Figure 24). An exception is in the production of *lame à crête*, or a crested blade, where multiple flakes are driven off to establish a ridge along the face of the core. Crest blade production should display signs of a prepared ridge along the exterior surface. Finally, cross sections of blades (Figure 25) are typically triangular or trapezoidal as opposed to lenticular (Collins 1999a). Interior attributes characteristic of Clovis blades include small, diffuse, bulbs of force as opposed to those that are salient or prominent, and interior surfaces that are smooth (Collins 1999a). Such attributes may reflect the type of percussor (hard versus soft hammer) used in blade manufacture. The quality (in this case, smoothness) of the interior surface of a blade may be difficult to establish in

Figure 24.

Directionality patterns on blades.

assemblages where weathering has affected the artifact's integrity.

Attributes of the Striking Platform Remnant

The platform remnant of a blade represents the location on a core where force was initiated by an implement, usually a soft or hard hammer. Platform remnants of blades often show signs of having been ground, though this trait is also present in specimens produced via prepared bifacial core reduction as well. In other cases, platform preparation entails the removal of small flakes resulting in faceted (dihedral), or multifaceted (polyhedral) platform remnants (Figure 26). Magne (1985) includes size and direction in defining platform facet types. The platform remnants of blades often form right angles between the core platform and core face (Figure 27), though angles for such blades may be as low as 60 degrees (Collins 1999; Dickens 2005). This measure is taken as the angle between the platform remnant and the longitudinal axis of the blade exterior. Platform angles of blade-like flakes, and those detached through biface reduction should have acute angles of 60 degrees or less. Platform remnant size is an attribute often used to distinguish lithic technology, as well as the specific techniques involved in manufacture. The width and depth (thickness) of the striking platform is taken with the aid of calipers. Because blade and biface production differ in terms of the methods and steps involved in their manufacture, platform remnant size is a principal attribute that may be used to distinguish different techniques of production. For the current analysis, Platform remnant size is recorded as a morphometric variable only, and is used as a method to characterize the Topper blade assemblage, and as a measure for comparison with other regional assemblages.

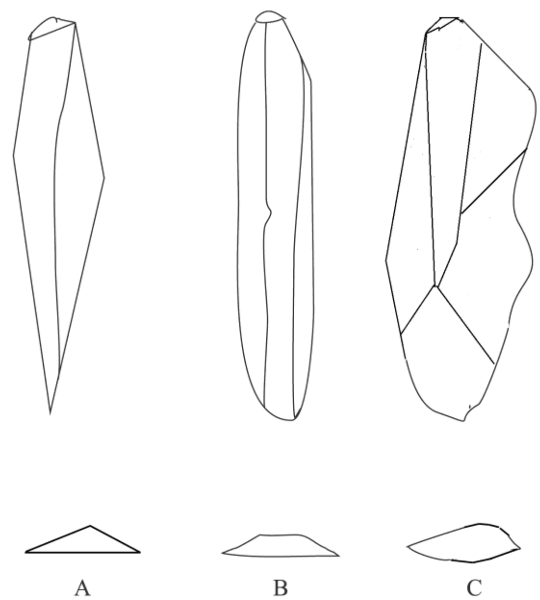


Figure 25.
Blade cross section classes. (A) Triangular, (B) Trapezoidal, (C) Lenticular.

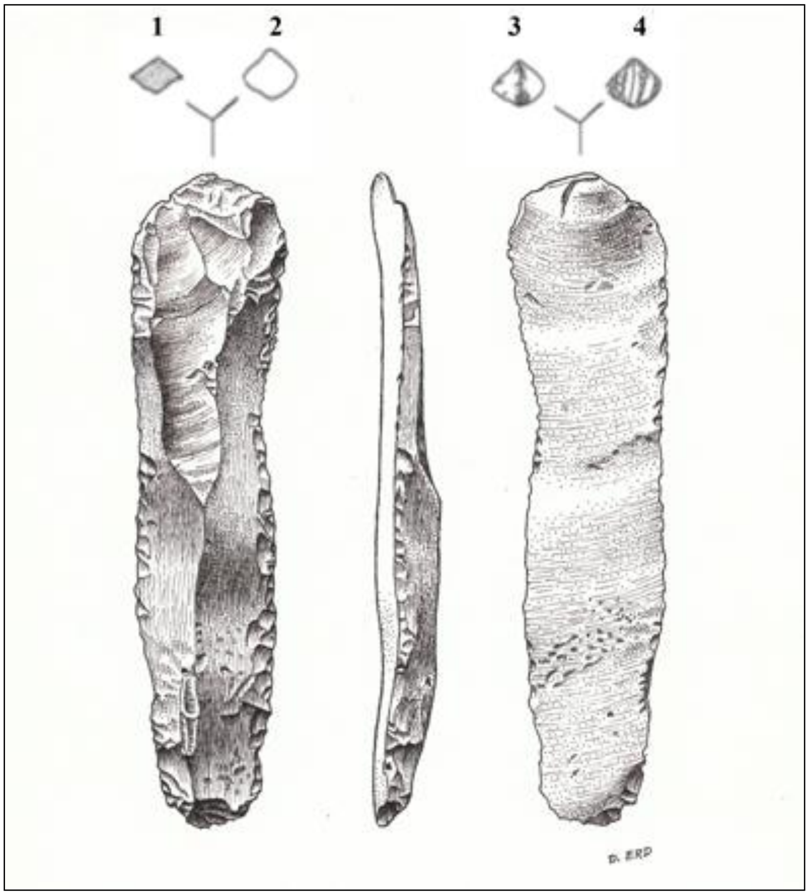


Figure 26. Platform remnant attributes recorded for blades. Numbers represent platform remnant types. 1: cortical, 2: plain, 3: faceted, and 4: multi-faceted. (Figure adapted from D. Erd).

Platform remnant size is an attribute often used to distinguish lithic technology, as well as the specific techniques (hard hammer, soft hammer etc.) involved in manufacture. The width and depth (thickness) of the striking platform is taken with the aid of calipers. Because blade and biface production differ in terms of the methods and steps involved in their manufacture, platform remnant size is a principal attribute that may be used to distinguish different techniques of production. For the current analysis, Platform remnant size is recorded as a morphometric variable only, and is used as a method to characterize the Topper blade assemblage, and as a measure for

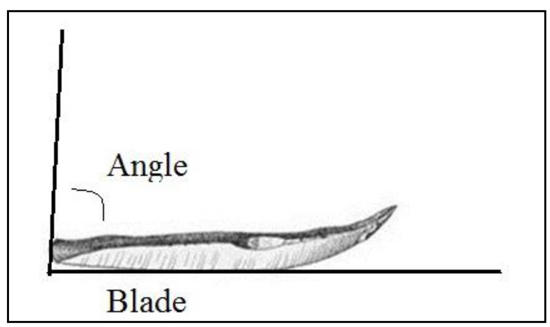


Figure 27.Method for measuring platform angle. Blades commonly exhibit platform angles of 60 degrees or greater.

Technological Attribute Analysis

For this analysis, each blade and blade-like flake was examined, observing the attributes of the exterior and interior surfaces, platform remnant, bulb, and lateral margins. Next, a list of 6 attribute categories was created that serve to differentiate blades from blade-like flakes (Table 5). Kilby (2008) has noted that Clovis blades have a number of technological attributes in common and that "aspects of the detached pieces reflect the character of the core from which it was derived" (Kilby 2008:53). These attributes include: small striking platforms with angles of 60-90 degrees, relatively parallel non-wavy lateral margins, parallel removal scars present, profile curvature skewed to distal end, and Cross-section that are triangular, prismatic, or trapezoidal (Kilby 2008). In order to be a blade, Kilby concludes that a detachment must meet at least three of the preceding criteria (Kilby 2008).

Each attribute was weighted with a value ranging from 1-3, and is indicative of its importance in discriminating between blades and blade-like flakes. Attribute categories in order of significance include number and direction of removal scars on the exterior surface (3), cross section (3), lateral margin form (2), platform remnant angle (2), bulb prominence (1), and distal longitudinal thickness (1). Attribute weights were selected based upon those attributes that prior definitions deemed most diagnostic for identifying blades. For this procedure, a value of 1 is an attribute of lesser importance, whereas a value of 3 is of highest significance. Because blades are struck systematically from a core, the presence of prior blade removal scars on the exterior surface of a blade is a greater indicator of blade manufacture than bulb prominence, an attribute that is also informing about technique. Likewise, the attribute lateral margin form is informing more about the specific design strategy applied for a standardized reductive approach (blade manufacture) than is distal longitudinal thickness. Although each of the six attributes is employed as a means to differentiate blades and bladelike-flakes, some attributes are favored over others Each blade or blade- like flake examined is given a total score, taken as the sum of all weighted values given for each attribute category (Table 6).

If an artifact does not exhibit the specific attribute, it is given a score of 0 for that particular attribute category. The maximum total value an artifact can obtain is 12. Artifacts receiving a summed value of 7 or greater are arbitrarily regarded as blades. Those with a summed value of less than 7 are classified as blade-like flakes. As such, the greater the summed attribute value, the greater the likelihood that an artifact is the product of technological blade manufacture. Finally, a chi square test is performed for the number of artifacts for each summed score. This test allows comparison of observed frequencies to expected (equally distributed) frequencies. The procedure outlined above provides a systematic rather than arbitrary method for distinguishing blades from blade-like flakes, and allows the attributes recorded to be quantified and compared statistically.

To summarize, blades have two or more parallel flake scars on the exterior surface that emanate from the same margin, and in the same direction. These blades also have "even, parallel lateral margins" (Collins 1999:9). Where multiple scars are present, they are unidirectional or bi-directional, but

Table 5.

Attributes used to determine reductive approach.

Attribute Category	Blade	Blade-Like Flake
Directionality	Uni-directional	Multi-directional
Cross Section	Triangular/Trapezoidal	Lenticular
Lateral Margin	Parallel/Wavy	Irregular
Platform angle	Angle >60	Angle <60
Bulb prominence	Diffuse expanded	Salient prominent
Distal thickness	Distal > Proximal	Proximal > Distal

usually not multidirectional. Additional attributes include cross-sections that are triangular to trapezoidal, platform angles of 60º or higher, diffuse bulbs of force, and distal terminations that are thicker than proximal ends. As no single attribute should define a blade, a method is employed that examines a suite of attributes, and allows results to be quantified for comparative purposes.

Morphologic Attribute Analysis

In addition to the technological attributes listed above, morphologic measurements are taken of blades and blade-like flakes (Table 7). While they do not establish a specific technological production approach, they are used here as an aid in interpreting the sequence or "stages" of manufacture at Topper, and can allow comparisons to be made with other assemblages. Blades and blade-like flakes are initially examined, noting condition and class. Condition refers to completeness (whole, proximal, distal), and presence or absence of post detachment modification.

Class refers to position in the reduction sequence to which a particular specimen belongs, and is identified through examining the presence and absence of cortex on the exterior surface. Measurements are taken on blade weight, length, width, index of curvature and platform remnant width and thickness (Figure 28).

Measurements of blades and blade-like flakes are taken only on complete segments, or items that exhibit a specific observable attribute. Incomplete blades are identified by the presence of parallel flake scars on the dorsal surface. All measurements are taken with the aid of calipers in mm, and weight is taken with digital scales measured in grams. In addition, the exterior and interior surface of each artifact examined is photographed using a Nikon D90 Digital SLR camera. Photograph numbers are subsequently provided, and serve as an archive of the collection.

All blades were classified as to the presence or absence of post detachment modification. Where modification is observed, location

Table 6.
Blade weighted attribute values

Attribute Category	Weight	Blade
Removal scar directionality	3	Uni-directional or bi-directional
Cross section	3	Triangular/Trapezoidal
Lateral margin	2	Parallel
Platform remnant angle	2	>60
Bulb prominence	1	Diffuse
Distal longitudinal thickness	1	Distal>Proximal

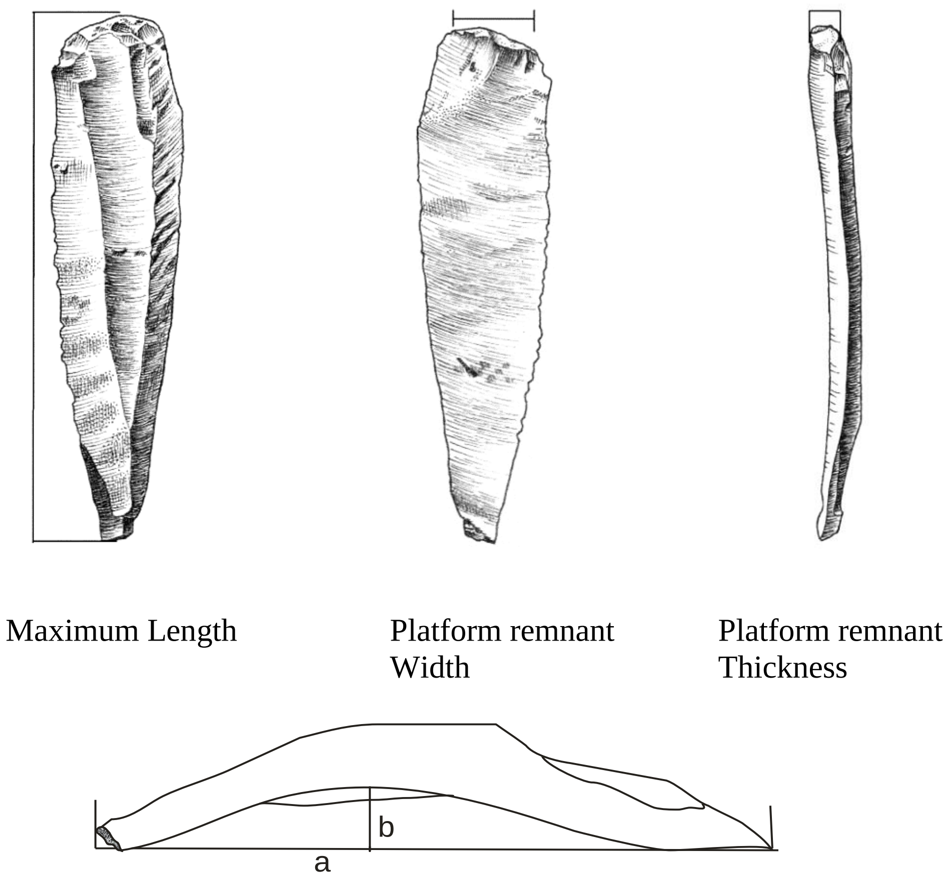


Figure 28. Diagram showing methods used for measuring blade attributes. A and B represent dimensions used to calculate index of curvature. (Adapted from Dickens 2005).

Table 7. Morphological measurements recorded for blades.

Blade Length	The maximum length in mm from the proximal to distal end of blade.
Blade Width	The maximum width in mm taken on a straight line perpendicular to the blades length.
Platform Width	The maximum width in mm taken from the lateral margins of the remnant.
Platform	The maximum thickness in mm, measured from the exterior to interior of the platform remnant, and perpendicular to the platform remnant This measure combined with platform remnant width reflects platform remnant area.
Index of Curvature	A ratio of two measurements. These measurements include (a) blade and (b) the maximum length taken of a straight line perpendicular to the interior surface of the blade. Total blade length is used here, as smaller blades may appear to have greater amounts of curvature than longer and vice versa. Only complete blades that exhibit a platform remnant are used.

and nature of modification on each specimen is recorded. Modification includes utilization or retouch, and applies to any type of trimming (unifacial or bifacial), at any angle, that is restricted to any margin or edge of an artifact (White et al. 1963). This may be accomplished either through production, use, or rejuvenation of a tool during its life span. The presence of modification is identified macroscopically, as well as with the aid of a hand lens.

Blade Type

During the manufacture process, a range of blade classes may be produced. For this study, blade class is assigned based upon the presence or absence of exterior surface cortex. The presumption being that as core reduction progresses with detachments removed sequentially from the core face, lesser amounts of cortex should exist on the exterior surface of blade detachments, while the number of prior removal scars on detached pieces increases. However, initial core preparation may remove some cortex prior to blade detachment. Studies of biface production and amorphous core reduction have shown that exterior surface cortex amount, considered alone, is not sufficient for assigning flakes to stages of reduction. Rather, such analyses should be combined with measures of exterior surface scar count to provide a more robust indicator of reduction. For this analysis, each blade is examined, recording presence or absence of cortex, and number of removal scars. In addition, as reduction progresses, blades should exhibit higher indexes of curvature as the core is reduced in size. Classes of blades considered in this analysis include primary decortication, secondary reduction, and interior blades (Figure 29). Each class is defined as follows:

Primary decortication blades:

Primary decortication blades are those artifacts in which (1) the entire (or most) exterior surface is covered in cortex, and (2) there is no evidence of prior *blade* removal scars. However, some initial core/nodule preparation may lead to the removal of some cortex at the proximal end of a blade. These removals typically take the form of small flakes that terminate just below the striking platform on the exterior face of the core, and are evidence of shaping and prepping the core prior to detachment. If such scars are present, yet the remaining exterior surface is cortical, then the detachment is recorded as a primary blade. These blades represent initial or early stages of core reduction. Primary decorticulations blades are first series of blades removed from a core. The core preparation removal scars at the blade proximal are used to distinguish technological blade manufacture, from completely cortical detachments that may be twice as long as they are wide and take the form of blades

Secondary reduction blades:

Those in which the exterior surface is partially covered in cortex. At least some portion of the objective piece interior is present on secondary blades. Secondary blades often exhibit single to multiple conchoidal flake scars on the platform remnant.

Interior blades

Those blades without cortex on the exterior surface. These blades represent later stages of blade manufacture if they were detached from the core in a sequential order. Interior blades display multiple scars of previous blade detachments on the exterior surface. Interior blades often exhibit two or more scars on the exterior surface (Clarkson 2007).

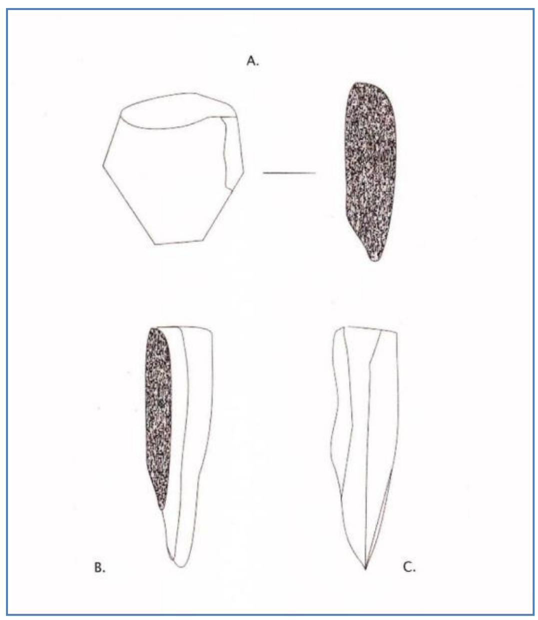


Figure 29.

Stages in the manufacture of blades.(A); Core and initial decortication blade. (B); secondary blade. (C); Interior blade.

Core Analysis

Core analysis is conducted to determine the technological approach of tool production (i.e., blade versus other approaches), and to track changes in core form during the sequence of reduction. Here, a series of attributes is recorded for each core, including the number and directionality of removal scars, platform characteristics, and any evidence of rejuvenation. Clovis blades are produced from prepared cores (Collins 1999a), either conical, cylindrical, or wedge in shape. Prepared cores are identified by the presence of one or more platforms, and with at least one removal scar on the face of the core (Collins et al. 2003). Platforms of such cores are typically faceted or ground. In addition, platform preparation scars should exist at the proximal end of such cores.

Conical cores are identified by the presence of multiple parallel removal scars about the circumference of the core. Furthermore, such scars should emanate from a single platform at one end of the core, and terminate at a single point forming a cone shape. Among conical cores examined from the Gault site, Collins finds these scars to frequently end in "steps or hinges" (Collins et al. 2003:113). Core rejuvenation of conical cores can be identified by the absence of a negative bulb at the proximal end of each removal scar.

Cylindrical cores are similar to conical cores in that they have multiple parallel uni-directional blade removal scars on the exterior face of the core that were struck from a single platform. However, cylindrical cores do not exhibit a tapered end. Removals from the distal ends of cylindrical cores served to overcome error and create a more uniform shape. The distal ends of cylindrical cores did not serve as a second platform for the removal of blades. Unlike conical or cylindrical cores, wedge shaped cores have two or more platforms. Wedge cores have acute angles between the platform and removal scar surface (Dickens 2005). Such cores are identified as having bi- directional or overlapping blade removal scars on the exterior surface of the core.

Unlike blade cores, bifacial cores have acute margins, multiple flake scars, "often ovate and small to moderate in size, and that are directed inward" (Haynes and Huckell 2007:208). Flake cores are amorphous, with multi-directional flake scars, and often have more than one platform (Haynes and Huckell 2007).

In addition to establishing the type or types of technology Topper cores represent, it is also possible to model sequences or stages of core reduction. This is accomplished through examining changes in a series of technological and morphologic attributes of cores. A set of eight attributes is used in this analysis. Five attributes are used to distinguish core type as well as reduction intensity (Table 8). An additional three attributes (weight/flake scar ratio, length of last removal scar, presence or absence of cortex) are used here to determine if any given core from the assemblage was discarded during early, middle, or late stages of the reduction sequence.

One attribute used as a measure of reduction is the number of removal scars that exist on the core face. Higher quantities of such scars are considered to reflect increasing/later stages of core reduction. Similarly, as the sequence of reduction progresses, so too does the number of hinge and step terminations found on the face of the core. Platform facet count may also be used as a measure of reduction. Cores with cortical platforms are considered to reflect initial or early stages in the reduction

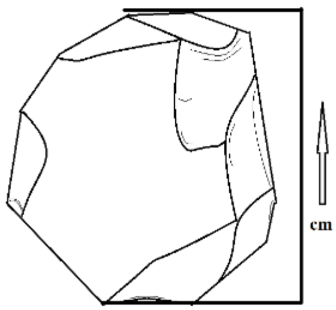
Table 8. Core attributes used to determine technological production approach.

Attribute	Blade Manufacture	Flake Core Manufacture
Platforms	1-3	Multiple
Blade Removal scars	2+	0
Directionality	Uni/Bi-directional	Multi-directional
Maintenance	Rejuvenation	Rejuvenation absent
Core type	Conical/Cylindrical Wedge	Amorphous

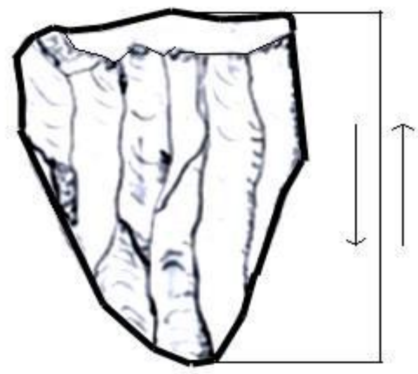
process. In contrast, decreasing amounts of cortex on the core are found to be present as reduction intensifies. As the number of core platform scars increases, platforms become increasingly faceted, eventually leading to the need for core rejuvenation.

Finally, measures of core weight and size (length and width) are taken of each core, along with observations on raw material quality. In measuring formalized blade cores, length is the distance from the proximal to distal end, taken parallel to the axis of blade removals "regardless if this is the longest axis" (Collins et al. 2003:109) (Figure 30). As core mass decreases with continued reduction, so too does the weight, platform area, and average flake scar length of each core. Therefore, a ratio of weight to removal scar count is used as a measure of the degree of core reduction. For this measure, high values indicate that a given core still has a substantial weight, given the number of remnant removal scars that are present on the exterior face of the core (low reduction intensity). Alternatively, a low weight to flake scar ratio is indicative of greater reduction intensity.

When a core has been reduced to the point where successful blade detachment of the intended specification is no longer possible, the core is discarded and may be exhausted. In some cases, however, poor raw material quality encountered early on in the production sequence may have inhibited successful detachment of blades from the core. In such cases, these cores may exhibit evidence of inclusions or vugs, as well as attempts to overcome such impurities leading to step and hinge terminations along the exterior face/platform juncture of the core. If such problems are encountered early in the reduction sequence, the core would have likely been discarded. Moreover, a core may be discarded because the number of requisite blades is attained early in the reduction sequence. If exhausted blade cores of high quality are found at Topper, it may indicate that blade



A



B

Figure 30.Method used to measure cores. For amorphous cores (A), length is defined as the greatest distance between two ends. For the formalized blade cores, (B) length is defined as the distance from the proximal to distal.

production was the goal of core reduction. In contrast, if most cores are found to exhibit few removal scars, or signs of early stage reduction, then I assume that either these cores were being tested and discarded early, or that subsequent reduction was for the purpose of producing cores as opposed to blade manufacture.

Cores discarded during early stages of reduction have cortical or nearly completely cortical platforms, fewer than 10 removal scars on the core face, and a weight to removal scar ratio greater than 50. In contrast, cores discarded late in the reduction sequence lack cortex on the core platform, have 15 or more blade removal scars, and core weight to removal scar ratios of less than 10.

Chapter VI

ANALYTICAL RESULTS

This research examines a sample of 333 blades and blade-like flakes, and 87 cores recovered over a span of thirteen seasons of field-work at the Topper Site. The sample derives from a total of 472 artifacts previously identified as blades, and 87 artifacts identified as blade, biface, and flake cores. Those artifacts not from Clovis contexts, or complete blades that are less than 30mm in length were not included in the sample. This chapter provides the results of an attribute analysis performed for each individual artifact. For the blade analysis, each artifact is identified and recorded as either a blade, or as a blade-like flake. This analysis operates under the assumption that blade production may be differentiated from approaches that result in the production of blade-like flakes based upon a suite of six attributes. These attributes are the number and direction of previous removal scars, cross section, platform remnant angle, lateral margin, bulbar definition, and a measure of proximal to distal thickness. Each attribute was weighted with a value ranging from 1-3, and is indicative of its importance in discriminating between blades and blade-like flakes. The sum of the values for each attribute was recorded, and is listed as the attribute value in Table 9.

The data resulting from the attribute analysis are presented in Appendix 1. Each attribute is assigned a numerical value ranging from one to three. Higher values represent attributes that are most indicative of technological blade production. For this study, blades are arbitrarily considered as those artifacts with a summed attribute value of seven or greater. This number was chosen as artifacts with attribute values of less than seven would have fewer attributes of blade technology. In contrast, blade-like flakes are artifacts with a summed value of six or less. Cores are classified as either formalized (conical, cylindrical, wedge) blade, flake, or generalized. As is the case for blades, core identification is also based upon a series of technological attributes. This section begins with a detailed discussion of the Topper blades, with emphasis given to the specific observable attributes present on each blade. Next a description of the blade-like flake class is provided, followed by a comparison of both artifact classes. Sequences in the manufacturing trajectory are modeled through an analysis of cortex present on artifact exteriors and exterior scar count. Finally, this chapter c with the results of the core analysis.

Results of Blade Analysis

Table 9 provides the total number of blades identified for each attribute class. Based on the results of the attribute analysis, a total of 257 blades, broken blades, and blade segments were identified from a sample of 333 lithic artifacts. Most blades have summed attribute values that are less than twelve (244 of 257). The findings here suggest that in most cases, at least one attribute used to define blade manufacture is missing from a given blade. Only thirteen blades were found to have summed attribute values of twelve. The presence of so few blades that exhibit all six attributes of blade manufacture may indicate that (1) either such blades were not produced in high quantities at the site, or (2) if they were

Table 9. Blade attribute value frequencies.

Attribute	Directionality			Cross Section			Margins		Bulb		Plat. Ang.		Thick	Total
Value														
Blade (77.2%)	Uni	Bi	Multi	Tri	Trap	Lent	Par	Irreg	Dif	Sal	> 60	< 60	P>D	
12	10	3	0	11	2	0	13	0	13	0	13	0	0	13
11	61	14	0	58	17	0	75	0	75	0	75	0	75	75
10	17	3	0	15	5	0	12	8	18	2	15	4	7	20
9	46	7	4	45	11	1	27	30	57	0	34	8	44	57
8	61	11	6	42	30	6	76	2	76	2	13	0	19	78
7	10	3	1	11	1	2	1	13	14	0	3	5	8	14
BLF (22.8%)														
6	22	2	11	24	4	7	31	4	34	1	15	3	21	35
5	7	1	6	2	2	10	12	2	14	0	4	0	5	14
4	4	0	3	1	0	6	0	7	7	0	2	1	2	7
3	7	2	6	2	0	13	0	15	14	1	4	1	8	15
2	0	0	1	0	0	1	0	1	1	0	0	0	0	1
1	0	0	2	0	0	2	0	2	2	0	0	2	2	2
0	0	0	2	0	0	2	0	2	0	0	0	0	1	2
														333

*Blf refers to blade-like flake; Uni refers to unidirectional scar; bi = bidirectional; Multi = multidirectional. Tri refers to triangular cross section; Trap = trapezoidal; Lent = lenticular. Par refers to parallel margin; Irreg = irregular. Dif refers to diffuse bulb of force; Sal = salient. P refers to proximal end and D refers to distal end.

produced, these blades were removed offsite.

In order to examine the blades more thoroughly, all artifacts were categorized according to completeness. Categories include complete blades, blade proximal ends, medial segments, and distal fragments. All blades within each category were subsequently examined, noting the condition according to specific attributes of the exterior and interior surfaces, platform remnant, and profile. If one has some knowledge of the nature of lithic reduction and design choice relative to the success or failure of lithic detachment, then by documenting artifact completeness and the attributes present for each category, he or she can make inferences about the reductive approaches that were employed in tool manufacture.

Blades (N=257)

Most blades examined for this analysis are complete, (Figure 31) though the occurrence of broken blades and blade segments is high (Table 10). Of the broken blades, proximal

Table 10. The number and percentage of blades and blade-like flakes by completeness.

	Blades			Blade-like flakes	
	Total	%		%	Total
Complete	139	54.09	Complete	60.52	46
Prox.	62	24.12	Prox.	5.27	4
Med.	40	15.56	Med.	14.47	11
Dist.	16	6.23	Dist.	19.74	15
Total	257		Total		76

fragments occur in higher frequencies than medial or distal fragments. Broken proximal blade fragments (Figure 32) are often a byproduct of detachments that step or hinge. Such fragments can also occur as error recovery and core rejuvenation detachments. All proximal fragments exhibit a point of applied force. At Topper, most of these artifacts exhibit uni-directional scars (82%) on the exterior surface as opposed to bi-directional scars (13%). Many proximal fragments also have multiple uni-directional scars that step or hinge immediately beneath the striking platform. Such patterns are one by-product of repeated failed attempts to detach a blade. An example is depicted in Figure 32.

Additional attributes of blade proximal fragments include cross sections that are predominantly triangular (71%) as opposed to trapezoidal (27%), and platform angles that range from 56 to 80 degrees. Blade medial fragments (Figure 33) are those broken blades without a striking platform or a distal end (Andrefsky 1998). An examination of the Topper blade medial fragments found most (55%) to have cross sections that are trapezoidal in form, possible indication that removal scars increased in number, as distance from the striking platform also increased. A trapezoidal cross-section is produced through the detachment of at least three parallel blades from a core. Trapezoidal cross sections are most often found on interior blades, those from later sequences in the reduction trajectory. The patterns found at Topper would seem to indicate that most medial fragments were broken during later stages of the manufacture process, though it is possible that such segments were derived for certain tools. However, the low occurrence of modification found on medial fragments onsite implies otherwise

Blade distal fragments (Figure 34) occur less frequently at Topper. These blades may be characterized as lacking a striking platform, yet do exhibit a termination. At Topper, distal fragments exhibit terminations that are most frequently feathered (9 of 16) as opposed to those that hinge (4 of 16). Step terminations are absent for the distal blade class. This pattern is indicative of breakage at some point subsequent to detachment. Like proximal and medial fragments, most distal fragments exhibit uni-directional scar patterns on the exterior surface. In order to examine the broken blades more thoroughly, a Chi squared test was conducted to compare the observed values to expected frequencies for each fragment type.

Figure 31. Complete blades recovered from the Topper Site.

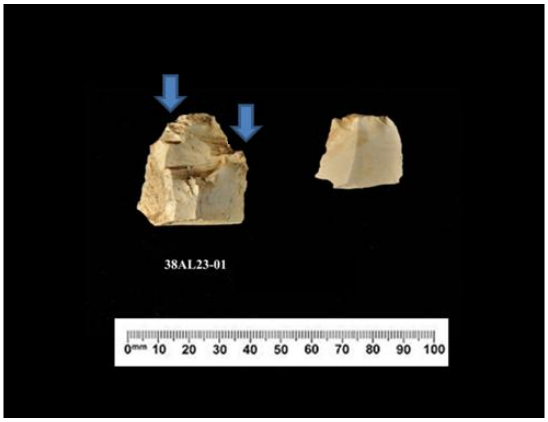


Figure 32. Proximal blade fragments recovered from the Topper Site (38AL23). Arrow shows evidence of repeated failed attempts of blade detachment.

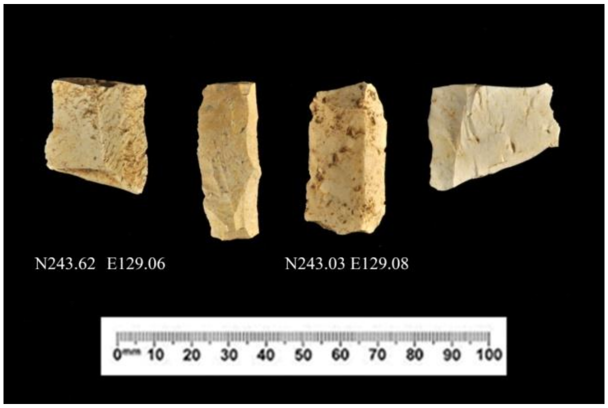


Figure 33. Blade medial fragments from the Topper Site (38AL23).

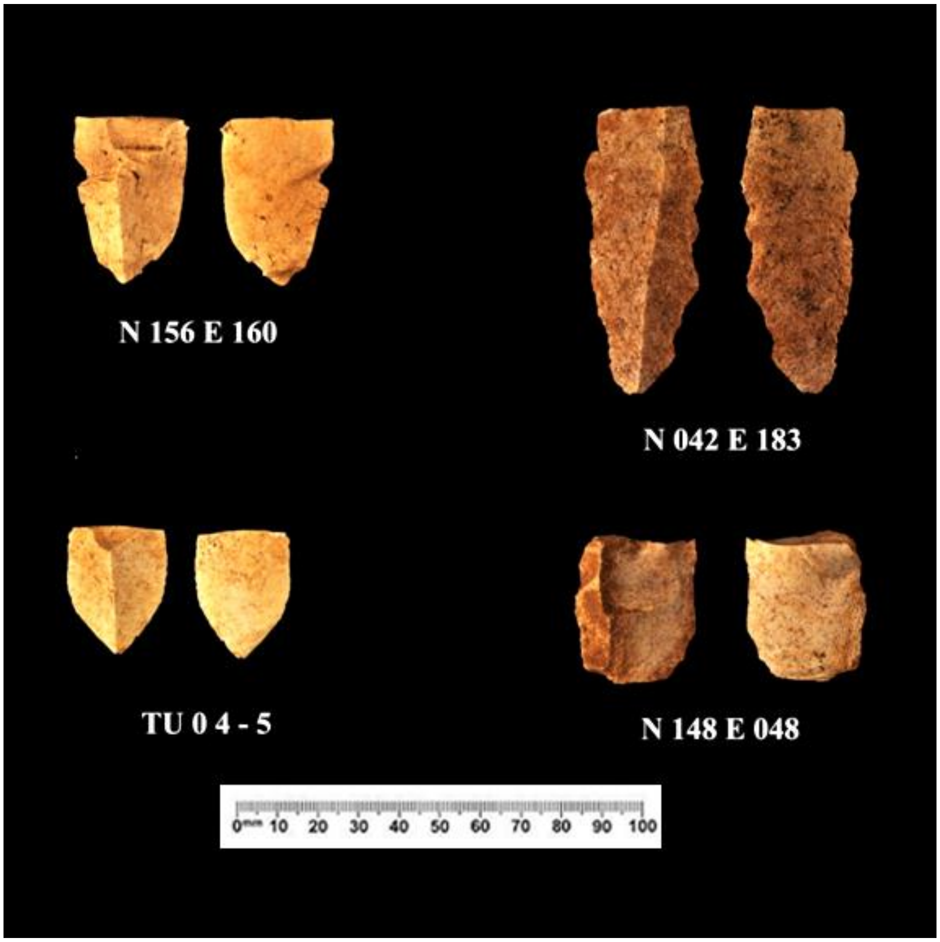


Figure 34. Blade distal fragments from the Topper Site (38AL23)

The results (Table 11) show that the observed chi square value falls into the region of rejection, indicating that there is a statistically higher frequency of proximal fragments that terminate in hinges or steps than should occur by chance. This pattern is consistent with a high frequency of blades that snap upon impact, resulting in broken blades. Detachment failure in such a manner may occur as a factor of the raw material morphology, or as a result of the technique used to detach a blade.

Likewise, a Chi square test was conducted to compare blade completeness to exterior scar directionality. This test evaluates whether the observed pattern for scar directionality conform to the expected frequencies for each artifact completeness category. It is used to determine if artifact category (completeness) is independent of scar directionality, or alternatively, if directionality varies in proportion to artifact completeness. Results of this test (Table 12) show that the observed chi square value falls into the region of rejection.

When complete blades were examined according to attribute category (Tables 13 and 14), a number of patterns emerge. First, most complete blades (71%) at Topper have uni-directional scars patterns on the exterior surface.

Table 11. Chi square test comparing blade fragments.

	Observed	Expected	(O - E)	(O - E)²	(O - E)²/E
Proximal	62	39.3	22.7	515.29	13.11
Medial	40	39.3	0.7	0.49	0.012
Distal	16	39.3	-23.3	542.89	13.81
					X^2 = 26.932

* Degrees of freedom = 2; Critical Value = 0.1026 ; P = 0.000001; α.05

Table 12.

Bivariate Chi square test comparing blade scars on blade fragments.

	Observed	Expected	(O - E)	(O - E)²	(O - E)²/E
Prox/Uni	51	50.79	0.21	0.041	8.07
Med/Uni	35	34.43	0.57	0.3249	0.009
Dist/Uni	13	13.77	0.77	0.5929	0.4305
Prox/Bi	8	8.2	0.2	0.04	0.0048
Med/Bi	5	6.09	1.09	1.1881	0.195
Dist/Bi	3	2.22	0.78	0.6084	0.274
Total					X^2=8.9833

*Degrees of Freedom = 2; Critical Value = 5.99147; X^2=8.9833; P=0.0112; α.05

Bi-directional scar patterns are found infrequently. Uni-directional scars on the exterior surface of a blade are usually found when core reduction is performed in a uniform, systematic approach, as opposed to opportunistic reduction, which may or may not result in a blade. Figure 35 provides examples of Topper blades having uni-directional scar patterns, a blade with bi-directional scars, and finally a blade-like flake with multi-directional scar patterns.

Scar count is one measure of reduction intensity. At Topper, scar counts for complete blades with uni-directional scar patterns range from 2 to 11. On blades with bi-directional scars, counts range from 2 to 10. On average, blades with bi-directional scars have higher scar counts on the exterior surface than blades with uni-directional scars. Standard deviations are provided in Table 14.

Table 13. Attribute completeness for Topper blades.

		Directionality			Cross Section			Platform Angle
	Total	Uni	Bi	Multi	Tri	Trap	Lent	
Complete	139	106	25	8	107	24	8	67.8
Prox.	62	51	8	3	44	17	1	66.4
Med.	40	35	5	0	18	22	0	NA
Dist.	16	13	3	0	12	4	0	NA
Total	257	205	41	11	181	67	9	

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Table 14. A comparison of scar directionality by scar count on complete blades.

Scar Direction	Blades	Mean Scars	Standard Deviation
	106	3.01	1.8291
Bi-directional	25	4.76	2.1656

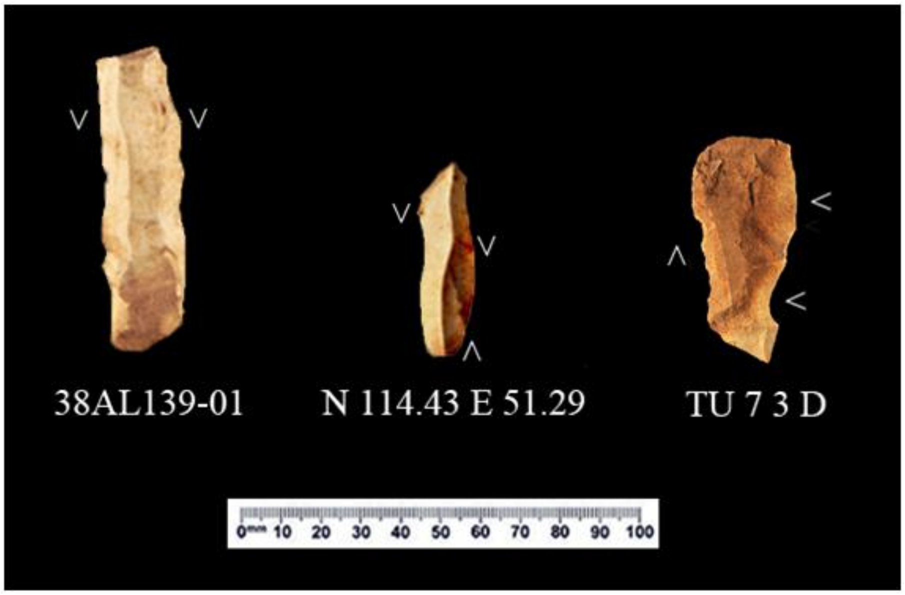

Figure 35. Diagram showing directionality patterns of prior removal scars found on Topper blades and blade-like flakes. From Left; unidirectional blade, bi-directional blade, multi-directional blade-like flake.

In most cases, bi-directional scars represent detachments struck from opposing ends of a core, and are parallel to the longitudinal axis of the blade. The presence of more scars on blades with bi-directional scar patterns may indicate that these blades were detached during later stages of the manufacture sequence. Bi-directional scars that intersect are rare, with only three such cases identified. Such patterns are more frequent for the blade-like flake class.

Blade cross sections also reflect past processes of reduction. When the sample was separated according to cross section, most (77%) complete blades were found to be triangular in shape (Refer to Table 13), indication of at least two prior blade detachments. A chi square test was conducted to test if the observed number of blades having triangular cross sections is greater than what may occur by chance. Results are presented in Table 15.

The number of blades at Topper with triangular cross sections represents a statistically significant departure from the expected. Patterns observed on the platform remnant of a blade reflect how the blade was detached, the intended technological approach, and also the success or failure of detachment. Platform angle is one such pattern. High angles of applied force result in platform angles that are also high. Equally, low angles of force should result in lower platform angles. Force, applied at a low angle, struck near the margin of the core/face juncture often result in shorter detachments, but require less effort (Clarkson 2007). In contrast, high angles of force, struck at distances further in from the margin of a core, and under knapper control, produce longer, straighter detachments, but require added force. The application of too much force on the platform margin can result in either a crushed platform or failed detachment.

At Topper, 26 blades and blade proximal-fragments exhibit crushed or missing platform remnants, evidence of error, misapplication of applied force during reduction, or post-detachment breakage. The platform angles are slightly greater on compete blades than on proximal fragments (Refer to Table 13). By comparing platform angle by blade completeness, we may derive some information on the manufacture techniques that produced successful detachments. If proximal fragments occur onsite as a by-product of detachment failure, then the pattern observed would seem to suggest a corollary between angle of applied force and blade detachment failure. However, to determine if there is a statistically significant difference between blade completeness and platform angle at Topper, a Student's T test was conducted comparing the distribution of platform angles for each completeness category (Table 16). The results of this test show that there is no statistically significant difference in mean platform angle and blade completeness. It should be of note that it is not possible to differentiate proximal fragments as the result of detachment failure, versus a by-product of post-detachment breakage.

When comparing blade length to platform remnant angle, complete blades with angles in excess of 60 degrees were found be longer (mean = 65.5mm) than those with angles less than 60 degrees (mean = 51.7mm). A T-test was also conducted to determine if there is a statistically significant difference in mean blade length compared to platform angle (Table 17). The results show that the means for each category are significantly different at the given confidence interval. However, due to the small sample of blades with platform angles of less than 60 degrees these results may be inconclusive. For the sample of blades

Table 15. Results of Chi^2 test for cross section type on complete blades.

	Observed	Expected	(O - E)	$(O - E)^2$	$(O - E)^2/E$
Triangular	107	65.5	41.5	1722.25	26.3358
Trapezoidal	24	65.5	-41.5	1722.25	26.3358
					X^2=52.671

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Table 16. T-test comparing blade completeness to platform angle.

	Mean platform angle	Standard Deviation
Complete blades (n=139)	67.69	7.38
Blade proximal fragments (n = 62)	66.4	6.48

* Degrees of freedom = 165, T-statistic = 1.1211, P = 0.2638, α.1.

Table 17. T-test comparing blade platform angle to complete blade length.

	Mean Blade Length	Standard Deviation
Platform Angle > 60 (n = 125)	65.5	28.8491
Platform Angle < 60 (n = 14)	51.7	15.7234

*Degrees of freedom = 113; T statistic = 1.6813; P = 0.0954; α .1

examined, if we assume angle of applied force can affect blade completeness, at Topper this effect is minimal. However, this variable does appear to influence the length of detached blades, and that this departure is statistically significant. Other factors that may have influenced total blade length, in addition to force application, include raw material size, shape and property.

One of the most distinguishing characteristics of the Topper assemblage is the percentage of artifacts examined that have diffuse or resolved bulbs of force. Such patterns are consistent with soft hammer direct percussion. Prominent bulbs are identified as a sharp protrusion just below the point of impact at the juncture of the platform remnant and interior surface. They are distinguished from diffuse bulbs as they are raised higher off the interior blade surface. Less than 2% of the identified blades have bulbs that are salient or prominent (Refer to Appendix I). Unlike blades with diffuse bulbs of force, salient bulbs are often associated with hard hammer percussion (Crabtree 1970:148; 1972:9). The blades that do exhibit a salient bulb of force at Topper also typically terminate in hinges, and have irregular lateral margins. Finally, distal termination thickness was used as an attribute to distinguish blades from blade-like flakes. Interestingly however, only 41of the identified blades (29.5%) have distal terminations that are thicker than proximal ends.

To summarize, most blades at Topper exhibit some, but not all attributes consistent with technological blade manufacture. The attributes that occur most frequently on blades are uni-directional exterior scar patterns and triangular cross sections. Through isolating specific technological variables such as angle, location and amount of applied force, and striking implement we can form a better understanding of the processes that generate individual blade attributes such as condition, scar pattern, cross section and platform characteristics.

Blade-Like Flakes (N=76)

Artifacts that are morphologically similar to blades, yet do not share the technological attributes of blades, are referred to as blade-like flakes. By definition, blade-like flakes have at least three of the following attributes: Multi-directional removal scars on the exterior surface, lenticular cross sections, irregular lateral margins, and platform remnant angles of 60 degrees or less. When the entire sample (333) of artifacts from Topper was examined using the cumulative attribute analysis, 23% of the artifacts exhibit attributes characteristic of blade-like flakes. Examples of such flakes are depicted in Figure 36. These artifacts have cumulative attribute values of six or less. Blade-like flakes were found in much fewer numbers than blades at the site. Of the artifacts identified as blade-like flakes, most (93%) have attribute values that range from three (3) to six (6). However, all but two blade-like flakes exhibit at least some attributes commonly associated with blade manufacture. Most blade-like flakes are complete (Table 18). Broken blade-like flakes include proximal medial, and distal fragments.

Blade-like flakes at Topper generally have multiple removal scars on the exterior surface. Scar counts for complete blade-like flakes range from 1 to 8, with an average scar count of 3.5. Scar patterns on blade-like flakes can range from parallel, to bisecting. Moreover, such artifacts usually consist of at least two uni-directional scars,

Table 18. Artifact attribute by completeness for Topper blade-like flakes.

		Directionality			Cross Section		
Blade-Like Flake	Total	Uni	Bi	Multi	Tri	Trap	Lent
Complete	46	19	3	24	17	1	28
Proximal	4	3	0	1	2	0	2
Medial	11	9	0	2	4	1	6
Distal	15	10	2	3	6	4	5
Total	76	41	5	30	29	6	41

Figure 36. Blade-like flakes from the Topper Site.

overlapped by additional multi-directional scars that bisect or are diagonal to the primary axis of the flake.

Comparison of Blades and Blade-Like Flakes

As a supplement to the technological attribute analysis that served to distinguish blades from blade-like flakes, a number of additional attributes were examined and recorded for each artifact. These attributes include quantitative measures of length, width, thickness and weight (Appendix II); and platform remnant size. Other attributes recorded include the presence or absence of cortex; presence and degree of post detachment modification; raw material type and quality, and platform remnant class. Such analyses may aid in forming interpretations regarding sequences of manufacture, in issues relating to technological organization, and for inter assemblage comparisons.

Blade size can be influenced by a number of factors including how the core was held prior to detachment, the implement chosen to strike a blade, as well as the angle and depth of applied force. Likewise, platform remnant size is an indicator of the implement, angle, and amount of applied force taken when striking a core. Blades detached with a broad-surfaced implement, such as a soft hammer billet, are more likely to result in platform surfaces with greater sizes than those blades detached with the aid of a small–tipped percussor or punch.

The descriptive statistics for each measure were recorded, and are presented in Table 19 according to class. Results of this analysis reveal a number of patterns. First, blades appear to be longer and thinner than blade-like flakes. Blades are also heavier than blade-like flakes. Blade-like flakes have more pronounced curvature than blades. Blades and blade-like flakes were found to have similar platform sizes indicating that they both may have been detached with the aid of a similar sized implement. To test the significant difference for the measures of these attributes, a T-test was conducted using a confidence interval of $\alpha = .1$. Results are presented in Table 19. The results of this test demonstrate that the quantitative measures of blade length and blade weight represent a statistically significant departure when compared to the same measures on blade-like flakes. Though variation does exist for the measure of index of curvature, such variation is not significant.

In addition to platform size, the platform class for each artifact was recorded (Table 20). Classes include plain, cortical, faceted, multifaceted, and crushed. These attributes can reflect methods of core preparation prior to detachment. The greatest proportion of blades (38%) has platform remnants that are plain. However, there is greater variation present for the blade-like flakes, with most having platform remnants that are missing (37%).

The short lengths, and relatively high indexes of curvature found for blade like flakes at Topper might imply a reduction technique incorporating soft or hard hammer direct percussion with a broad–ended implement, force applied at low angles, and with the core secured loosely. A loosely held core often results in detachments that are curved as the core can rotate as force is being applied Such techniques are commonly found in early stages of blade or biface core reduction, with little prior platform preparation. The longer blades, with relatively low indexes of curvature, and wide striking platforms are indicative of soft or hard hammer direct percussion, with a broad–ended implement, force applied at deep high angles, and with the core secured more firmly.

Table 19. Descriptive statistics for morphological attributes of blades and blade-like flakes. SD. = Standard deviation.

	Blades		Blade-Like Flakes				
	Mean	SD.	Mean	SD.	Alpha	T-statistic	Probability
Length	63.8	26.6	59.8	15.6	0.05	1.7178	0.0875
Width	24.5	10.7	25.2	8.4	0.05	0.3496	0.727
Weight	18.1	25.6	10.6	10.5	0.05	1.8593	0.0648
Curvature	3.98	3.9	5.07	4.1	0.05	1.597	0.112
platform width	12.3	7.0	12.6	6.8	0.05	0.2312	0.8174
Platform thickness	6.2	4.2	6.4	5.2	0.05	0.2932	0.7698

Table 20. Platform type by artifact class for complete blades and blade-like flakes.

Platform Remnant	Blades %	BLF %
Cortical	14.2	6.5
Faceted	15.6	17.4
Multi-faceted	9.2	10.9
Plain	38.3	28.3
Crushed	8.5	4.3
NA	14.2	32.7

Grinding adds strength to the platform, and allows for more control in producing a desired detachment. Grinding was directly observed on 13 platforms. Artifacts identified with ground platforms include three complete blades, four blade-like flakes, and six proximal blade fragments. Grinding was found to overlap faceted or multi-faceted platform remnants on the three blades. For the blade-like flakes and proximal fragment classes, the presence of grinding was observed on faceted, multi-faceted and plain platforms. All artifacts that exhibit evidence of platform grinding have bulbs of force that are either diffuse, or are absent. Finally, raw material type was recorded for each artifact. Results show that with the exception of a single blade medial section, all artifacts are a product of Allendale Coastal Plain chert (Appendix I).

Raw material quality is variable. Artifacts produced from lesser or poor quality material typically exhibit inclusions and evidence of multiple step or hinge terminations. Due to the highly weathered nature of the Clovis chert artifacts at Topper, it is unlikely that the raw material in its present form is the same as at the time of extraction. As such, it is difficult to assess whether surfaces that appear of inferior quality today, were of optimal quality at the time the piece was detached.

Cortical Analysis

A number of attributes may be used as measures of lithic reduction. One attribute often used as is the presence and amount of cortex found on the exterior surface of lithic artifacts. Studies have shown that artifacts with lower percentages of exterior surface cortex are representative of later sequences in the reduction process (Andrefsky 1998). Therefore, each artifact was examined, noting the presence or absence of exterior cortex for each piece. Five classes of blades and blade-like flakes were created (Table 21). Classes include primary decortication, secondary, and interior blades, as well as corner and crested blades. Each class is defined below, along with the results of analysis.

Primary/Decortication Blades (N=4)

There are four artifacts identified as decortication blades. These include two complete primary blades, one corner blade-like flake, and a single blade proximal fragment (Figure 37). Mean morphological measures recorded for each cortical class are provided in Table 22. The Topper primary decortication blades represent the smallest sample of any artifact class identified in this analysis. Primary decortications blades may be characterized as relatively large, with parallel or irregular lateral margins. These artifacts lack evidence of prior blade removal scars on the exterior surface. They are triangular in cross-section, have diffuse bulbs, exhibit thick, wide platform remnants ranging from cortical, plain, to faceted. Moreover, the index of curvature for primary decortication blades is on average greater than that of blades produced during later stages in the reduction sequence. The lack of primary decortication blades onsite may indicate alternative methods chosen for the initial removal of blades from the core, or simply may indicate the testing of a nodule. One such method includes the removal of cortex through lateral flaking in the preparation of a crested blade.

Secondary Blades (N=63)

Secondary blades (Figure 38) are artifacts that exhibit at least partial exterior surface cortex, but that are not entirely covered with cortex. Sixty three artifacts were assigned to the secondary reduction stage. This number includes 48 blades and 15 blade-like flakes. Most of these artifacts (49) are complete. An examination of the attributes found on complete secondary blades revealed a number of patterns (Tables 23-26). First, secondary blades are on average shorter, and exhibit less pronounced curvature, than primary decortication blades. Such patterns may be expected as the reduction process progresses and core size is reduced. Next, most secondary blades have uni-directional removal scars on the exterior surface. The cross sections on these blades are more often triangular in form as opposed to trapezoidal. Striking platforms, when present, are predominantly plain or cortical rather than faceted or multi-faceted. Finally, secondary blades have greater platform angles than occur on primary blades.

Two categories of secondary blades were identified from the sample; those with more regular lateral margins, and blades with

Table 21. Blade class by reduction sequence.

Sequence	Blades (n)		Blade-like Flakes (n)	
Primary	2	1	1	0
Secondary	41	7	7	8
Interior	78	110	33	21
Crest	11	0	5	0
Corner	7	0	1	0
Total	139	118	46	29

Table 22.Mean lengths and indexes of curvature for blades and blade-like flakes by reduction sequence.

Cortical Class	Length Blades	Length BLF	Curvature Blades	Curvature BLF
Primary	87.5	42.8	6.36	8.73
Secondary	71.1	60.68	3.56	4.75
Interior	57.48	53.96	3.61	3.91
Crested	80.83	79.96	7.75	8.6
Corner	53.13	42.8	2.75	8.73

BLF refers to Blade-like flake.

Table 23. Cortical chert frequencies by cross section for complete artifacts.

Cortical Class	Blade			BLF		
	Tri.	Trap.	Lent.	Tri.	Trap.	Lent.
Primary	2	0	0	1	0	0
Secondary	33	4	2	4	0	3
Interior	51	20	6	9	1	23
Crested	11	0	0	3	0	2
Corner	7	0	0	1	0	0
Total	104	24	8	18	1	28

BLF refers to Blade-like flake.

Table 24. Cortical chert frequencies by scar directionality for complete artifacts.

Cortical Class	Blade			BLF		
	Uni	Bi	Multi	Uni	Bi	Multi
Primary	2	0	0	1	0	0
Secondary	30	10	1	1	0	6
Interior	66	10	2	16	3	13
Crested	3	3	5	0	0	5
Corner	5	2	0	1	0	0
Total	106	25	8	19	3	24

Table 25. Cortical chert frequencies by platform type for complete artifacts.

Class	Blades					
	Cort.	Plain	Faceted	Multi-faceted	Crushed	NA
Primary	0	1	1	0	0	0
Secondary	11	12	3	2	5	7
Interior	8	33	16	9	5	7
Crested	1	3	0	2	1	4
Corner	0	4	2	0	1	0
Total	20	53	22	13	12	18

Table 26. Cortical chert frequencies by platform angle and removal scar.

Cortical	Mean Platform Angle	Mean Removal Scar Count
Primary	62	.5
Secondary	68	3.4
Interior	67.5	3.5
Crested	69.5	6.2
Corner	64.8	3.3

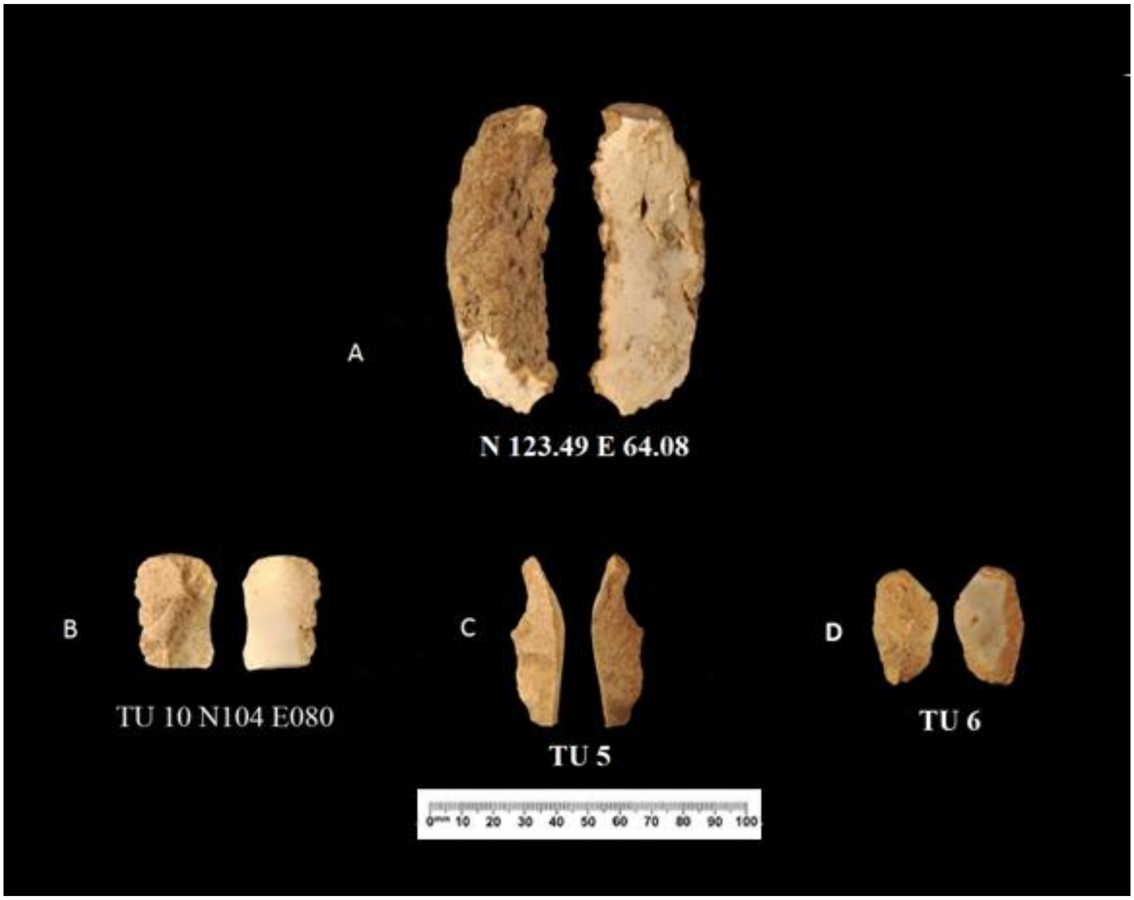

Figure 37. Primary decortications blades from Topper: A and C blades, B, proximal blade fragment, D blade-like flake.

Table 27. Artifacts by completeness for secondary blades and blade-like flakes.

Class	Complete	Proximal	Medial	Distal
Regular	22	3	3	0
Irregular	15	1	0	0
Blade-like flakes	10	0	5	3

Figure 38. Secondary blades from the Topper Site (38AL23).

irregular margins (Table 27). From this analysis I identified twenty-five complete regular secondary blades, and six blades that are broken or fragmented. Scar counts for regular secondary blades range from two to ten, with an average scar count of 3.8. Scar patters for the regular secondary blades include proximal to distal, lateral to medial (only on bi-directional examples), and proximal to lateral. In some instances multiple overlapping flakes have been detached toward a central ridge, suggestive of core preparation, maintenance or error recovery. Occasionally, these flakes terminate in hinges or steps.

There are sixteen secondary irregular blades, one of which is a proximal fragment (Figure 39). Attributes consistently found for these blades (Table 28) include removal scar patterns that are more frequently bi-directional in form. Such patterns are occasionally perpendicular to the primary axis of the blade, and terminate at the blade midline. Other scar patterns common on irregular secondary blades include proximal to distal, and proximal to lateral. Secondary regular and irregular blades have identical mean platform angles. Platform types vary in form but include cortical, plain, faceted, and multi-faceted varieties. Bulbs of force are diffuse. Morphologically, secondary irregular blades are longer, wider, and exhibit greater curvature than more regular secondary blades, though such blades are still shorter than primary decortication blades. A T- test was conducted to evaluate if the morphological disparity observed represents a statistically significant difference between secondary regular and irregular blades (Table 29). The results show that the observed differences are not statistically different.

Table 28. Technological attributes for regular and irregular secondary blades.

Category	Directionality			Cross Sec.		Platform	
	Uni	Bi	Mult	Tri	Trap	Cort/Plain	Fac./MF
Regular	20	5	0	21	2	14	3
Irregular	10	5	1	14	2	10	2
Blade-like flakes	1	0	9	5	0	2	4

Figure 39. Topper Secondary irregular blades.

Table 29. T-test for morphologic attributes of regular and irregular secondary blades.

	Regular Blades		Irregular Blades			
	Mean	SD.	Mean	SD.	T-statistic	Probability
Length	69.75	29.84	78.40	27.38	0.9411	0.3524
Width	25.76	11.52	31.45	11.03	1.5974	0.118
Curvature	3.5	3.726	4.57	3.75	0.9031	0.3718

In addition to secondary blades, there are a total of 10 complete secondary blade-like flakes. These flakes can be a by-product of any reductive approach. Secondary blade-like flakes generally exhibit multiple multi-directional removal scars, triangular to lenticular cross-sections, and irregular lateral margins. Morphologically, they are on average shorter and wider than secondary blades, with a mean length of 64.57 mm, and a width of 30.27 mm. Curvature is also more pronounced for the secondary blade-like flake class with a mean index of curvature of 7.53.

Interior Blades (N=242)

Interior blades and blade-like flakes (Figure 40) are artifacts that do not exhibit any cortex on their exterior surfaces, and are taken to reflect later stages in the reduction sequence. A total of 242 artifacts were identified as interior blades or blade-like flakes, the most for any cortical class identified at Topper. Most of these artifacts are broken fragments rather than complete specimens. Morphologically, complete interior blades are shorter than primary decortication or secondary blades (Refer to Table 23). Such blades tend also to be straighter in longitudinal profile. Technologically, most interior blades have uni-directional removal scars (84%). Most blades are triangular in cross-section. However, twenty six percent of interior blades are trapezoidal in form, a higher percentage than found on secondary blades (10%). Though platform remnants are most commonly plain, a high percentage of complete interior blades have faceted and multi-faceted platforms (32%) when compared to secondary blades (6.4%). This is possible indication that more attention was given to platform preparation during later sequences of blade manufacture.

There are two categories of interior blades: regular and irregular blades (Table 30). Regular interior blades are most common. This group includes 60 complete blades, 43 proximal fragments, 37 medial segments, and 16 distal sections. The exterior surfaces of these blades generally have two or more parallel uni-directional removal scars. Bi-directional scars occur less frequently. The number of removal scars on the exterior surface or regular interior blades ranges from one to 15, with a mean of 3.5 scars per blade. The cross sections of interior regular blades are triangular or trapezoidal. Platform remnants can be faceted or multi-

Table 30. Technological attributes for regular and irregular interior blades.

Category	Directionality			C/S		Platform	
	Uni	Bi	Multi	Tri	Trap	Cort/Plain	Fac./Mult. Fac.
Regular	49	9	2	38	15	30	19
Irregular	17	1	0	12	5	10	6

Cort. refers to cortical; Fac. refers to faceted; Mult. Fac. refers to multi-faceted.

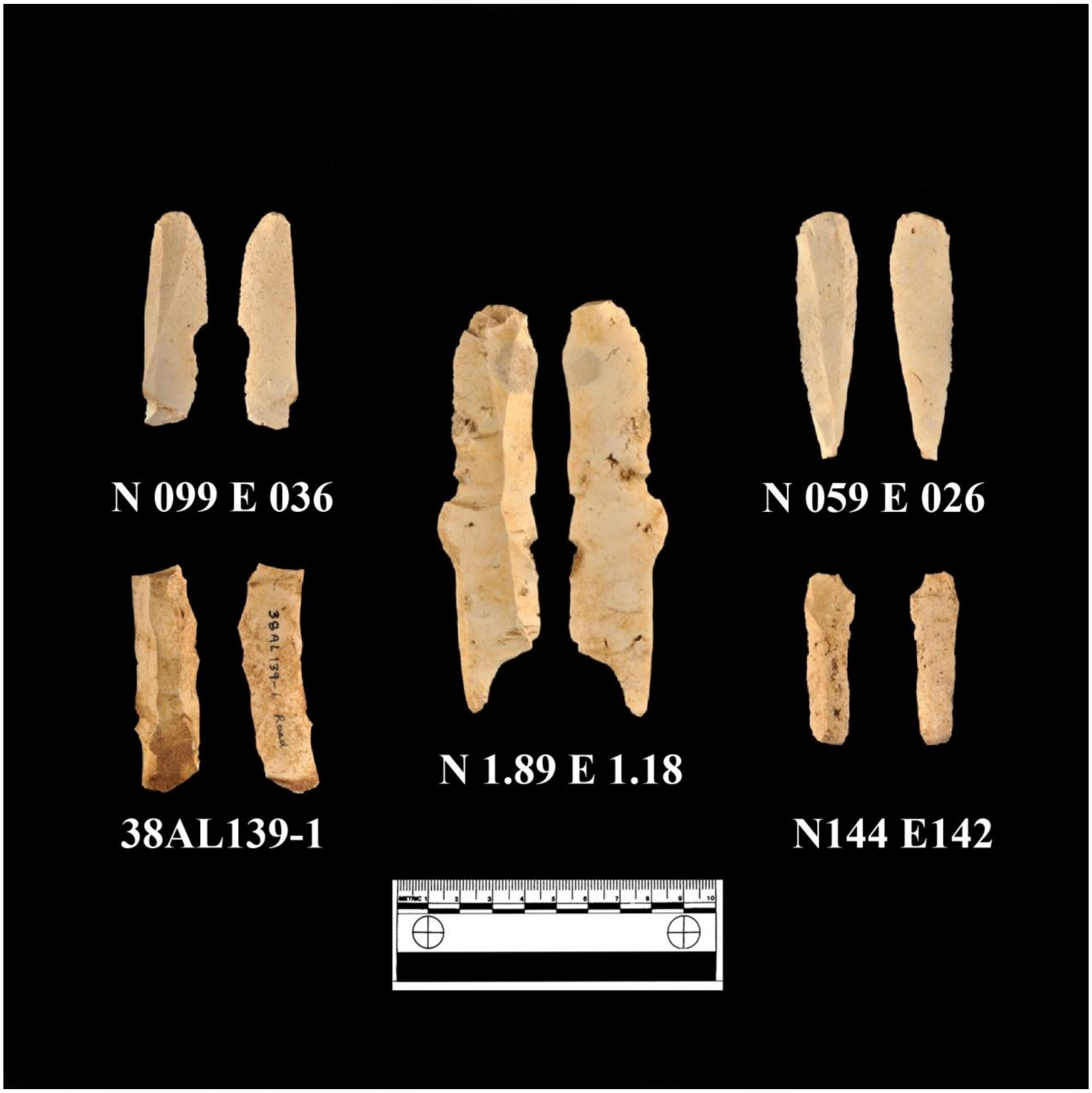

Figure 40. Topper interior blades.

faceted, although most are plain. Cortical and crushed platform remnants are rare. A total of seven regular interior blades (6 proximal fragments and 1 complete blade) have platform remnants that are ground. The grinding overlaps five platform remnants that are faceted to multi-faceted, and two that are plain. The distal terminations for complete interior regular blades are on average thinner than proximal ends, and bulbs are generally diffuse or absent. Finally, a total of four regular interior blades display some form of post detachment modification,

Irregular interior blades have asymmetrical lateral margins (Figure 41). These blades are most often a product of core maintenance, or are failed attempts to produce more regular, parallel blades (Dickens 2005). There are thirty interior irregular blades. This cortical class includes 17 complete blades and 13 blade proximal fragments. Bi-directional and multi-directional removal scars are rare. The number of prior removal scars ranges from two to seven, with a mean of 3.3 scars per blade. The cross-sections of complete irregular interior blades are most often triangular (12), with trapezoidal (5) forms occurring less frequently.

The platform remnants of irregular interior blades can be plain, faceted or multi-faceted. Cortical platform remnants are absent. Faceted platforms occur at higher percentages than on secondary blades. Morphologically, irregular interior blades are the smallest of any class. However, the results of a T-test found that the difference in blade length, width, and curvature for regular and irregular interior blades is not significantly different (Table 31).

A total of 55 interior blade-like flakes were identified from this analysis. This includes 33 complete specimens, twelve distal fragments, six medial segments, and four proximal fragments. These flakes generally have multiple non parallel and multi-directional removal scars on the exterior surface. Bi-directional and uni-directional scars are less common, however, when such examples are present, they tend not to be parallel. Thirty one of the interior blade-like flakes have cross sections that are lenticular. Interior blade-like flakes usually have irregular lateral margins which sometimes bend at the distal end. Finally, interior blade-like flakes are slightly shorter than interior blades.

Crested Blades (N=11)

Another class of blade is the crested blade or, *lame à crête*. Crested blades are a specialized form of blade, and are often a product of the core preparation process. However, crested blades may be produced during later sequences of reduction as well, such as in the lateral removal of flakes from the core face, conducted in an effort to rejuvenate the core. If a natural, straight ridge is not present on the core, one is created through the removal of a number of unifacial or bifacial flakes taken perpendicular to the longitudinal axis of the core. Such flaking often continues the length of the core face, aids in “the production of longer, thinner, and more parallel-sided flakes”, and “leaves straight scars on the core face which serve as guides for further blade detachments” (Crabtree 1972:31; Whitaker 1994:106). In addition, such removals create multiple platforms in which subsequent blades may be struck.

Eleven complete crested blades were identified from this analysis. Four of these are presented in Figure 42. Interestingly, no broken crested blades have been recovered. Conditions for these blades (Table 32) are as follows. Exterior surfaces generally exhibit multiple removal scars ranging from 2-17 in

Table 31. Morphological attributes for regular and irregular interior blades.

	Regular Blades		Irregular Blades			
	Mean	SD.	Mean	SD.	T-statistic	Probability
Length	59.303	26.0852	51.273	14.4048	1.2513	0.2144
Width	21.60	19.7487	23.663	10.6913	0.7792	0.4382
Curvature	3.867	3.8202	2.95	4.0887	0.8671	0.3886

Figure 41. Topper interior irregular blades.

Table 32. The percentage of crested blades by attribute condition.

Directionality (%)			Margins (%)		Termination (%)		Scars (%)	
Uni	Bi	Multi	Parallel	Irregular	Feather	Hinge/Step	1 -2	4+
27..3	27..3	45.4	72.7	27.3	54.6	45.4	27.3	72.7

Figure 42. Crested blades from the Topper Site

number, and with an average scar count of 6.2. Flaking patterns are usually bi-directional to multi-directional in form, with such removals often perpendicular to the longitudinal axis of the blade. In addition, removal scars occasionally terminate in hinges or steps below the center ridgeline. All crest blades have triangular cross sections, and diffuse or no bulbs of force. Furthermore, these blades generally have parallel lateral margins, are rarely irregular, and end in feather terminations. In some cases, artifacts appearing as crested blades can be produced from working a snapped biface. Morphologically, crested blades are long. Only primary decortication blades have mean lengths that are greater than crested blades. Crested blades are strongly curved in profile when compared to all other cortical blade classes at the site. Such curvature may reflect attempts to prepare an artificial ridge on chert nodules, whereby detachments will tend to follow the natural contours of the objective piece. Refer to Table 23 for a comparison of morphologic attributes for each blade class. A T-test was conducted to determine if there exists any significant difference in blade morphology between crested, secondary, and interior blades (Tables 33 and 34). The results indicate that there is a statistically significant difference in the attribute for curvature when crested blades are compared alongside secondary or interior blades.

Though crested blades often have multi-directional removal scars, one attribute used in this study to identify blade-like flakes, these blades should not be mistaken as such. The flaking patterns present on crested blades represent an intentional attempt to produce a specific outcome, in this case a prepared ridge. Multi-directional flaking patterns present on blade-like flakes can be the result of any number of reductive approaches. With this in mind however, this analysis found a number of blades that have multi-directional flaked (prepared) ridges, consistent with crested blades, yet also share other attributes common among blade-like flakes. Five such examples meet these criteria, and are referred to as crested blade-like flakes. These flakes exhibit more than four and as many as 13 multi-directional removal scars on the exterior surface. The lateral margins of crested blade-like flakes are irregular in shape. Second, they generally have platform remnant angles that are on average greater (74 degrees) than those observed on crested blades (69 º). A greater proportion of these flakes have lenticular cross-sections than do crested blades. Other attributes consistent with these flakes include diffuse bulbs of force, and thin distal terminations that tend to feather or hinge. Morphologically, crested blade-like flakes are shorter and wider than crested blades, with a mean length of 70 mm. Finally, most crested blade-like flakes have higher indexes of curvature as well. Because these flakes have many attributes inconsistent with blade production, it is possible they are a byproduct of other reductive approaches of lithic manufacture such as prepared biface production.

Corner Blades (N=7)

A final class of blade found at Topper is the corner blade (Figure 43). Corner blades are defined as blades that have been removed from the corners, sides, or ends of blocky or tabular raw material (Dickens 2005:166). These blades represent core preparation, and such removals may be produced multiple times throughout the sequences of core reduction.

During initial core preparation, corner blades would have been removed to set up and prepare for subsequent detachments. During secondary and later sequences of reduction, corner blades would have been removed to aid in resurfacing core platforms, or to correct errors such as hinge and step fractures. Such blades are generally triangular in cross-section, have short bi-directional flaking patterns on the exterior surface, often originating from the lateral margin, end in step or hinge terminations, and exhibit parallel or irregular margins. A total of seven corner blades were identified. The exterior surfaces of these blades exhibit multiple uni-directional to bi-directionally flaked removal scars.

Table 33. T-test comparing morphological attributes of crested and secondary blades.

	Crested Blades		Secondary Blades			
	Mean	SD.	Mean	SD.	T-statistic	Probability
Length	80.83	19.28	71.10	27.58	1.081	0.286
Width	29.05	6.88	26.60	10.44	0.726	0.472
Curvature	7.75	4.42	3.60	3.60	3.15	0.003
Plat. Angle	69.50	7.07	68.40	7.23	0.377	0.709

Table 34. T-test comparing morphological attributes of crested and interior blades.

	Crested Blades		Interior Blades			
	Mean	SD.	Mean	SD.	T-statistic	Probability
Length	80.83	19.277	57.40	24.92	2.989	0.0036
Width	29.05	6.884	24.52	10.70	1.381	0.1694
Curvature	7.75 0	4.424	3.59	3.74	3.370	0.0012
Plat. Angle	69.50	7.071	67.63	7.696	0.655	0.5142

Platform sizes are generally greater than those of blades or blade-like flakes.

A single corner blade exhibits platform remnant grinding. In this case, grinding was performed atop a faceted platform. Bulbs of force are diffuse, consistent with other classes of blades from Topper. The distal terminations of corner blades all end in hinges or steps. Moreover, all artifacts identified as corner blades exhibit triangular cross sections, though such cross sections tend to be more acute, having steeper angles than those found for other cortical classes at Topper. Morphologically, corner blades are shortest of any cortical class, in addition to having the lowest index of curvature.

Post Detachment Modification

The entire sample of artifacts was examined with the aid of a hand held lens for the presence of post detachment modification. Categories of modification include chips, breaks, striae and polish. Striae and polish may be a byproduct of use (Keeley 1974, Odell 1980). Of all artifacts examined, a total of 16 display evidence of some form of modification. Eight of these cases consist of breaks along one or more margins and are distinguished from snaps that produce

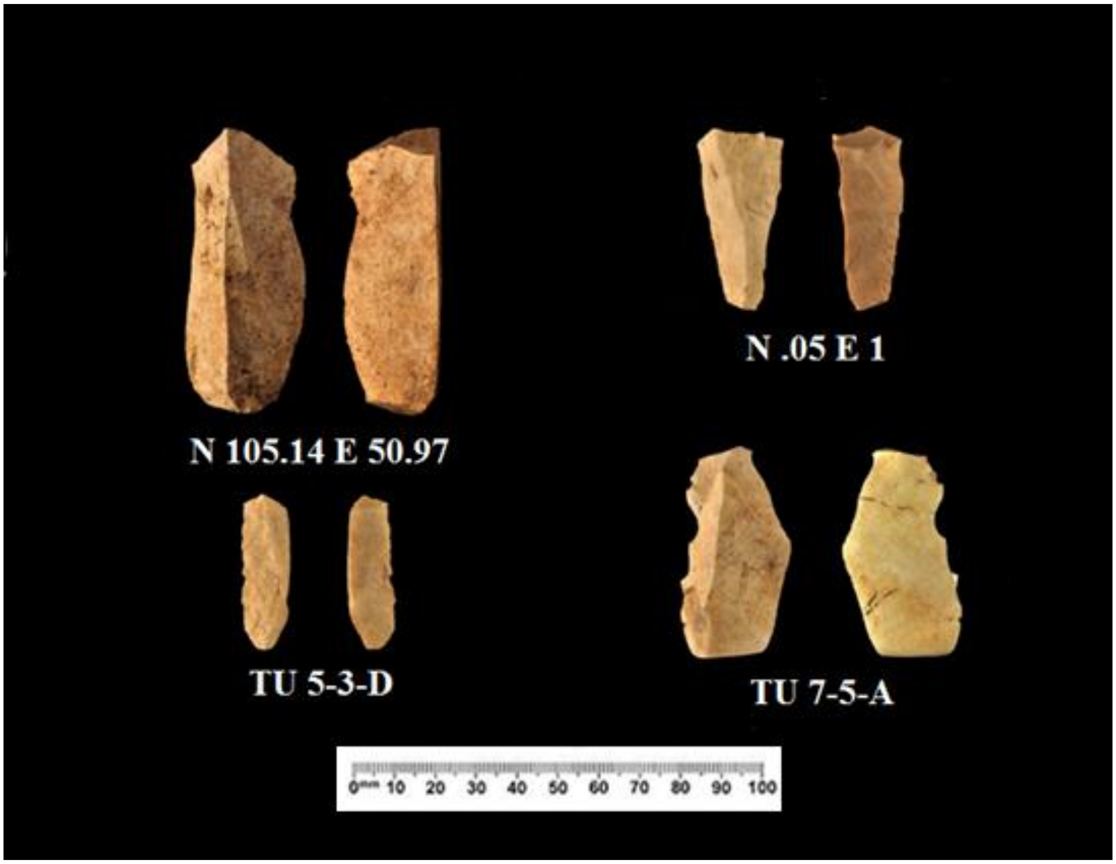

Figure 43. Topper corner blades.

fragments. Such breaks can occur as a result of the manufacture process, or as post-depositional alteration. They can also be the result of trowel or shovel damage incurred during the excavation process. A limitation of this analysis includes the differentiation of breaks as a cultural occurrence from those that are caused by post-depositional and/or natural processes. The remaining eight cases of blade modification consist of retouch, resulting from the systematic detachment of flakes from either lateral margin or end. These blades are referred to below as the modified blade class, and consist of six complete blades, one crested blade, and one blade distal fragment. Attributes for the modified blades are presented in Table 35. Figure 44 is an example of a modified blade recovered from the hillside excavation at the Topper Site.

When all modified artifacts were separated according to class, most (6 of 8) were found to be interior blades. This number includes four complete blades, one distal fragment, and one crested blade. The presence of post-detachment modification was not observed on primary blades, though such modification was found on two secondary reduction blades. When all of the modified blades and blade-like flakes were classified according to technological attributes, a number of patterns emerge. First, modified blades are long. The results of a T-test demonstrate a statistical difference for the lengths of modified and unmodified blades. Descriptive statistics for this test are provided in Table 36. Technologically, most modified blades have four or more scars of previous blade removals, parallel margins, feathered distal terminations, and diffuse bulbs of force. Although modified blades are predominantly interior, the average index of curvature is high though not statistically different than unmodified blades. When the modified blade class was examined according to directionality of previous removal scars, three blades were found to have multi-directional removal scars, three have bi-directional scars, and two blades have uni-directional scars. Platform remnants of modified blades are plain, faceted, or multi-faceted, with no examples showing evidence of having previously been ground. Platform angles are most often higher that 60, with a mean angle of 66.

All modified blades were examined, noting the location of modification. Four blades exhibit systematic retouch along a single margin. Such modification is an indication of rejuvenation of the blade margin in order to prolong tool use-life, or to modify the edge angle of the blade. The presence of polish was absent from all artifacts, though examination was only conducted macroscopically. One blade has retouch along both lateral margins, another exhibits retouch along the blade proximal end. A third blade exhibits retouch along the distal terminus. Finally, a single blade was found to have striations along the interior lateral margin consistent with use-wear. Such striations take the form of linear marks along the lateral margins of a blade. The patterns present for the Topper modified blade class indicate that blades with long, parallel sided lateral margins were most often selected for modification. However, the low density of such blades with modified edges at the site supports the conclusion that either such blades were not used in great numbers at the site, were used for non-intensive purposes, or were removed offsite for use elsewhere.

A Comparison of the Topper Assemblage to Other Known blade Assemblages

Collins (1999a) describes Clovis blades as having small platform remnants, and interior surfaces that are either flat or have no bulbs of force. Furthermore, such blades should be curved in longitudinal cross-section, and typically long, often exceeding 100mm in length (Collins 1999a:63,178). The results of this analysis have found that Clovis blades at Topper and the Savannah River Valley in general, frequently exhibit technological attributes that differ from Collin’s description of such artifacts. For example, at Topper, blades have wide, deep platform remnants, and are often straight in longitudinal section (Figures 45 and 46). Moreover, these blades are frequently shorter than 100mm in length. Only fourteen examples from a sample of 250 identified blades are greater than 100mm. On the other hand, some blades were found to have technological attributes similar to the description of the accepted Clovis blade definition. For example, nearly all blades at Topper were found to exhibit diffuse, flat bulbs of force. Likewise cross sections were generally triangular to trapezoidal in form, and platform remnant angles are predominantly in excess of 60º. Finally the blades from Topper that are greater than 100mm in length tend to have high indexes of curvature.

In an effort to evaluate the Topper blade assemblage more completely, known attributes of Topper blades were compared to those from blade assemblages at other known Clovis sites. The sites included in

Table 35. Attributes for Topper Modified Blades.

Provenience	Length	Width	I/C	Cross Sec.	P/A	Direct.	Cortical Class
N286 E138	26.14*	27.91	NA	Trapezoidal	NA	Bi	Interior
N122 E064	95.22	28.4	12.39	Triangular	NA	Bi	Interior
N100 E038	112.62	34.13	9.84	Triangular	68	Multi	Interior
N288 E136	143.9	47.66	0	Triangular	78	Uni	Secondary
N102 E054	141.38	67.2	9.05	Trapezoidal	60	Multi	Interior
N290 E132	42.2	28.03	8.11	Trapezoidal	54	Bi	Interior
N138 E036	51.33	27.47	0	Trapezoidal	64	Uni	Interior
N102 E054	95.14	36.09	4.1	Triangular	73	Multi	Secondary

* Blade distal; I/C = index of curvature; P/A = platform angle

Table 36. T-test comparing morphologic attributes for Topper modified and unmodified blades.

	Complete modified blades (n = 7)	Complete unmodified blades (n = 132) Mean (mm)	T-statistic	Probability
Length	97.4	62.075	3.558	0.0006
I/C	6.21	3.61	1.794	0.0754

*α=.05

Figure 44. Exterior, profile, and interior view of a modified blade from Topper.

Figure 45. Clovis blades recovered from the Topper Site (38AL23).

Figure 46. Illustration showing a typical Clovis blades recovered from the Topper Site. Note the slight longitudinal curvature, diffuse bulb of force, and wide platform remnant. Such attributes differ from traditional definitions of Clovis blades. (Image credit Darby Erd).

this analysis are Blackwater Draw in New Mexico, Richie Roberts in Washington, Keven Davis, Pavo Real, and Gault in Texas, Adams in Kentucky, Nuckolls in Tennessee, and Big Pine Tree in South Carolina.

The attributes that were compared include maximum blade length, index of curvature and platform width and thickness. Though the potential exists for inter-observer error, the blade attributes from four assemblages; Keven Davis, Richie Roberts, Pavo Real, and Blackwater Draw, were taken from Collins original study (1999a). All sites were statistically compared to Topper using the Students T-test. The results of this test are provided in Tables 37-39. When maximum length is considered, the Topper blade assemblage is significantly different from all other sites. The mean length for the Topper blades is shorter than that of blades from all sites with the exception of Big Pine Tree. Blade curvature at Topper was compared to four sites (Keven Davis, Blackwater Draw, Pavo Real, and Richie Roberts). The results indicate that the Topper blades are straighter than those examined by Collins and Dickens. Finally, the mean platform size of Topper blades was compared to blades at six sites. The results demonstrate that Topper striking platforms are statistically different in size than three sites: Nuckolls, Gault, and Keven Davis.

The original sample upon which Collins defined Clovis blades was largely based upon examples recovered from individual lithic caches, and not quarry and quarry-related reduction sites. This is true of Blackwater Draw, Keven Davis, and Richie Roberts. At these sites, blades tend to be long and curved. They are also found in lower frequencies than at quarry/production and habitation sites such as Big Pine Tree, Topper, and Nuckolls. If one assumes that blades recovered at cache sites represent artifacts intended for use, then the

Table 37. Results of a T-test comparing Maximum length of Topper and other Clovis blade assemblages.

	Site	Sample	Length	SD	T statistic	P value
	Topper	139	63.809	26.5727		
Collins	Keven Davis	13	95.077	33.3078	3.9675	0.0002
Dickens 2005	Gault	141	82.061	24.6011	5.9765	< .00001
Collins	Richie Roberts	5	95.4	25.0958	2.6158	0.0098
Collins	Pavo Real	13	104.308	28.9032	5.2169	< .00001
Collins	Blackwater Draw	11	137.545	30.6639	8.7617	< .00001
Ellerbusch 2004	Nuckolls	318	70.418	20.3753	2.897	0.004
Sanders 1990	Adams*	NA	82	NA	8.079	< .00001
Unpublished	Big Pine Tree	196	48.525	16.3975	7.0158	< .00001

* Adams published means (Sanders 1990); SD. = Standard deviation

Table 38. T-test comparing Index of curvature of Topper to Clovis blade assemblages.

	Site	Sample	Mean I/C	SD	T statistic	P value
	Topper	139	3.98	3.8698		
Collins 1999	Keven Davis	14	12.59	5.2302	7.6566	< 0.00001
Dickens 2005	Gault	112	7.55	3.1748	7.8371	< 0.00001
Collins 1999	Richie Roberts	5	14.38	0.7694	5.9852	< 0.00001
Collins 1999	Pavo Real	32	5.8	3.685	2.4559	0.015
Collins 1999	Blackwater Draw	9	12.88	2.1462	6.8222	< 0.00001

Table 39.T-test comparing Platform size of Topper and other Clovis blade assemblages.

	Site	Sample	Mean PW	SD	T statistic	P value
	Topper	116	12.262	6.9832		
Collins 1999	Keven Davis	10	6.54	2.2589	2.5711	0.0114
Dickens 2005	Gault	159	9.901	4.5981	3.3773	0.0008
Collins 1999	Pavo Real	24	14.125	8.3004	1.1508	0.2518
Collins 1999	Blackwater Draw	3	8.667	7.2342	0.9925	0.3308
Ellerbusch	Nuckolls	210	10.409	5.5548	2.617	0.0092
	Big Pine Tree	83	9.725	7.0863	2.5115	0.0128

technological and morphological attributes observed on such blades should denote those most essential for such use. Likewise, if one assumes that quarry reduction sites were areas where tools were reduced to various stages, then one should expect greater variation in blade attributes at and near quarry reduction sites.

At quarry reduction sites such as Topper, tools may have been reduced to various stages, and those that meet a specific, desired objective should represent examples best suited for use. Depending upon the desired function of the blade, such artifacts *may* have been transported elsewhere for use. Blades recovered at quarry and lithic production sites more often represent failed detachments or those unsuitable for use. It is predicted that blades recovered from other site types, apart from, and at distances from quarries, or recovered as isolated finds, should more often conform to the traditional definition of a blade as defined by Collins. This pattern of technological organization relates to model 2 as described in Chapter 1.

Core Analysis

A total of 87 cores were assigned to four classes based on a series of technological attributes. These were 51 generalized flake cores, or those lacking any formalized patterning, eight flake cores, or those that exhibit systematic flake removals from a common striking platform, 22 formalized blade cores, and six broken cores assigned to an indeterminate category. Attributes recorded for cores include platform condition, number of complete prior removal scars, hinge or step fractures (if present), platform angle, and a ratio of weight to flake scar count. In addition, measures of length, width, and weight were taken of each artifact. Attributes for all cores are provided in Appendix III and IV. The results of the core analysis are provided below.

Generalized Cores (N = 51)

Of the cores examined, generalized flake cores are the most abundant class. These cores do not fit the description of formalized blade cores (Figure 47). They are often amorphous, and exhibit little evidence of formal patterning or preparation. Moreover, the remnant scars found on generalized flake cores usually do not fit the definition of technological blades, though some may appear blade-like. Generalized cores likely represent flake production, or possibly early stage biface production. For this analysis, generalized cores were separated according to the remnant scar pattern observed on the core face. Categories include amorphous (n = 29), bi-directional (n = 2), multi-directional (n = 14), and indeterminate (n = 6). Generalized cores are characterized as having numerous multi-directional removal scars struck from multiple platforms, and frequently terminating in hinges or steps. Such removals appear to have been detached from various and opportunistic angles of the core, rather than in a systematic fashion. At Topper, amorphous cores often have material flaws such as inclusions, vugs, or coarse-grained interiors. In these cases, flaking appears to have been carried out in an attempt to test raw material quality, to remove material flaws, or to locate areas of higher quality raw material that would allow for the successful manufacture of blades, flakes, or bifaces.

Sizes for amorphous cores tend to vary widely. As amorphous cores do not exhibit formalized patterning, measurements were taken differently than for more formalized cores. Amorphous cores often have multiple platforms from which flakes were struck in multiple directions. Therefore, the lengths of amorphous cores were measured as the greatest distance (mm) between two points along a straight-line axis of the core. Core widths were measured as the greatest distance between two points at an angle perpendicular to core length. Accordingly, the average length for amorphous cores was found to be 80.6 mm with a width of 66.3 mm. Amorphous cores have a mean flake scar to weight ratio of 19, higher than that found in more formalized blade cores. This ratio is a measure of core reduction, and monitors the amount of raw material that remains once reduction has ceased, and at the time a core was discarded. Finally, the removal scars on amorphous cores are both shorter and wider than are found on more formalized blade cores, with the last detachment averaging 42.2 mm.

In addition to amorphous cores, 15 artifacts were identified as multi-directional cores. These cores have scars (or platforms) on two or more faces. They are distinguished from amorphous cores by the presence of at least two flake removals detached from the same platform. Otherwise, multi-directional cores share similar attributes with amorphous cores.

Flake Cores (N = 8)

Flake cores (Figure 48) show signs of having been flaked in a systematic or patterned approach. They are used for the production of flakes as opposed to blades, though some remnant scars may appear blade-like. Flake cores represent formalized flake production, whereby flakes were removed systematically from a common striking platform and may be differentiated from informal or opportunistic reduction. Eight artifacts from the Topper assemblage were identified as flake cores. These cores can have flake removals struck from uni-directional (n=1), bi-directional (n=4), or multi-directional (n=3) patterns. Cores with multi-directional scar patterns have the highest number of remnant scars. Morphologically, flake cores are wider than they are in length. The presence of flake cores onsite may reflect attempts at formalized blade manufacture, but in instances where raw material condition and or quality preclude the success of production. In such instances, the reduction may have resulted in an unintended outcome: the production of flakes or blade-like flakes as opposed to blades.

Formalized Blade Cores (N =22)

A total of 22 artifacts are identified as formalized blade cores. These cores exhibit technological attributes consistent with blade production. Attributes include the presence of two or more parallel removal scars on the core face struck from one or more prepared platforms. Formalized blade cores at Topper include a single cylindrical core, two that are conical in shape, and twelve identified as wedge shaped cores. Seven artifacts were classified as indeterminate blade core fragments.

Cylindrical Cores (N = 1)

A single cylindrical core was identified from the Topper assemblage (Figure 49). Cylindrical cores have two opposing platforms. One serves as the primary platform from which blades are detached. The opposite platform is only used for core maintenance; to rejuvenate the core, straighten the core face, or to correct errors. The single cylindrical core is shorter in length than it is wide (Refer to Table 40). The entire circumference of this core has been flaked, leaving cortical material absent from the core face. This core has a high number of remnant scars on the core face compared to the conical cores. Many remnant scars on this core overlap. Removals were detached from a single, acute faceted platform. Three of the remnant scars exhibit negative bulbs at the

Figure 47. Topper Generalized flake core.

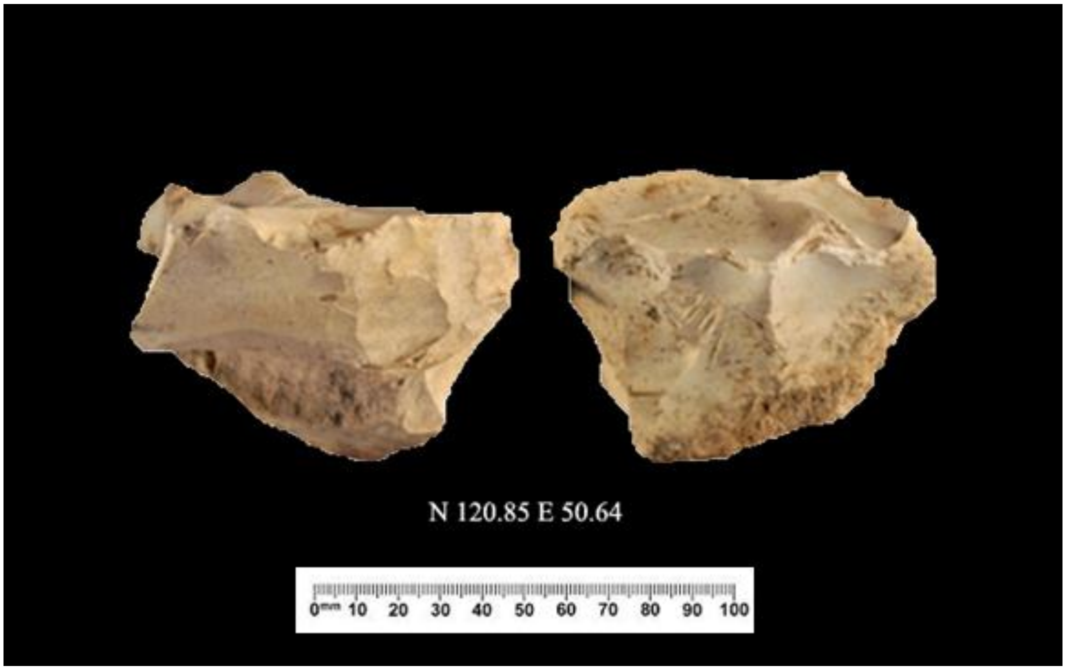

Figure 48. Topper flake core.

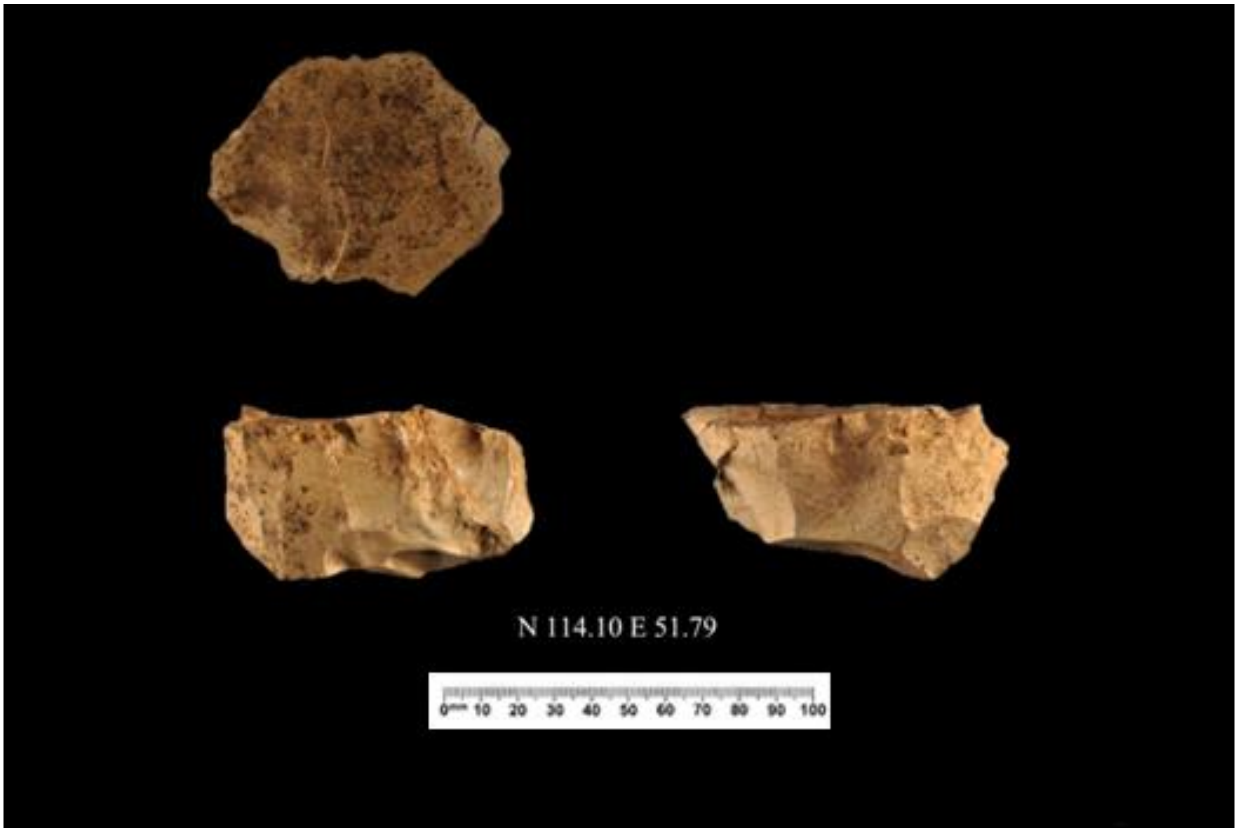

Figure 49. Topper Cylindrical blade core.

Table 40. Morphological attributes for conical and cylindrical cores.

Class	L	W	Weight	Scars	W/RS	P/A	L/RS	% Flaked
Conical	56	74.76	189.08	14	13.557	65-70	46.76	75
Conical	37.36	90.07	207.32	16	10.36	55-60	57.05	100
Cylindrical	41.4	81.8	322.23	19	16.95	55-60	36.00	

W/RS= Weight to removal scar; P/A=Platform angle; L/RS=Length longest removal scar.

Table 41. Mean Morphological attributes for all formalized cores.

Core class	L(mm)	W(mm)	Weight	Scars	W/RS	L/RS	Error term	Con.scars
Cylindrical	41.43	81.8	323.23	19	16.95	36.05	7	3
Conical	46.68	82.42	198.2	15	11.96	51.91	5.5	5.5
Wedge	82.07	66.4	277.36	10.58	25.96	70.52	3.08	2.91
Indeterminate	79.45	65.49	114.92	5.86	14.96	60.16	1.28	1.14

Length and width measured in mm, weight measured in grams.

Table 42. Morphological attributes for complete wedge shaped cores.

L(mm)	W (mm)	Weight	Scars	W/RS	P/A	L/RS	Error term.	Directionality
53.85	104.71	184.49	20	9.22	76	48.72	11	Multi-directional
105.76	111.61	914.0	14	65.30	NA	94.95	6	Multi-directional
102.89	67.84	638.0	19	35.60	NA	93.3	4	Multi-directional
39.55	54.18	82.23	9	9.13	66,76	42.93	0	Bi-directional
123.42	59.4	413.0	8	51.60	NA	97.99	5	Bi-directional
42.88	66.51	156.57	12	10.43	75	64.95	2	Bi-directional
78.06	77.38	398.05	13.06	30.21	75.5	73.8	4.7	

W/RS= Weight to removal scar; P/A=Platform angle; L/RS=Length to flake scar platform core face juncture. The negative bulb scar on one of these removals is deeply concave, while others are relatively flat. Scars that do not have negative bulbs were likely detached at earlier points in the manufacturing trajectory, suggesting that this core was once much larger, and has been rejuvenated through the removal of a core tablet flake.

The final removal scar on the face of the core is also the longest detachment still remaining. In addition, a total of seven remnant scars end in hinge or step terminations. Most of the remnant scars on this core are short and terminate almost immediately below the platform. There is flaking along the distal end of the core, yet there is no evidence for attempted blade removals from this surface. According to Collins (1999a), such flaking may have been conducted as a means to realign core form, allowing for the future detachment of blades that are flat as opposed to curved.

Conical Blade Cores (N =2)

Collins defines conical blade cores as cone-shaped cores having blade removal scars along the axis of the core face at approximate right angles to the plane of the platform, and with most of the circumference of the cores flaked (Collins 1999a:51). The broad end serves as the platform, and removals terminate at a single point at the distal end of the core. Two artifacts are identified as such from the Topper assemblage, both complete specimens (Figure 50). These cores each have a single platform from which multiple (10+) unidirectional removal scars were struck (Table 41). Such flaking results in the production of blades that are curved and have feathered terminations as with each sequence of removals, the distal end of the core becomes increasingly smaller (Bordes and Crabtree 1969:2).

At Topper, a single conical core has blade remnant scars around the entire circumference of the platform. The second conical core exhibits flaking on three of four sides. The condition of each conical core is provided in Table 40 and described below. The first conical core (N159 E77) has a small region of the core face that still retains cortex. Of the removal scars, six terminate in hinges or steps, and many others are overlapping and uni-directional. Some of these appear to be morphologically more similar to flakes than to blades or blade-like flakes. In addition, this core has four platform conchoidal scars along the core face/platform juncture, and platform preparation is present in the form of small flake removals along and adjacent to the platform margin. Such preparation may have been conducted in the process of forming a promontory from which to strike and detach a blade. Finally, this core has the greatest weight to removal scar ratio for any core from its class, indicating that it may have been discarded earlier in the reduction trajectory.

The second conical core (N 122.55 E 64.06) is shorter, wider, and heavier than the first (N 159 E 77). The second core also has more removal scars. There are seven platform conchoidal scars present along the core face/platform juncture, and the bulbar scar of three of these removals is moderately concave. A total of five removal scars end in either hinge or step terminations. The single striking platform is acute and plain, with the

Figure 50. Topper conical blade core.

exception of small flake removals detached from the platform margin. Finally, this core has a smaller weight to removal scar ratio than core (N 159 E 77) suggesting that it was discarded at a later stage in the reduction process. Late stage blade cores recovered onsite are one indication that blade manufacture was the goal of reduction as opposed to preformed core production.

Conical blade cores exhibit high numbers of blade removal scars on the core face, and have low ratios of weight to blade removal scars. The blade scars on conical cores are short, and frequently end in hinge or step terminations. In addition, conical cores have multiple platform conchoidal scars. Occasionally, these scars form deep concavities, an indication of the desire to strengthen platforms, increase the length of blades, and control platform angles (Clarkson 2007). The presence of such attributes on conical cores at Topper is one indication that these cores have been reduced to near exhaustion. When cores reach such a state, ensuing detachments begin to take the form of flakes or blade-like flakes, as opposed to technological blades.

Wedge-shaped Cores (N = 12)

Twelve artifacts are identified as wedge-shaped cores (Figure 51). Six of these cores are complete, while an additional six are core fragments. Complete wedge-shaped cores have technological and morphological attributes that differ from cylindrical and conical cores (Tables 41 and 42). At Topper, complete wedge-shaped cores have at least two striking platforms from which blades were detached. Moreover, they exhibit remnant removal scars that are bi-directional to multi-directional in form. Platforms can be plain, faceted, or multi-faceted. Complete examples are most often faceted to multi-faceted, and have platform angles ranging from 66-90 degrees. The platform angles found on cylindrical or conical shaped cores are more acute (51-70 degrees). Morphologically, complete wedge shaped cores are longer and narrower than cylindrical and conical cores. Complete wedge shaped cores have longer, yet fewer remnant blade scars than cylindrical or conical cores. The scar counts on wedge shaped cores range from eight to 20 for complete examples, and from five to 13 removals for fragments. When the final removal scar on each core was measured to determine length, lengths were found to range from 42.9mm to 97.9mm, with a mean length of 73.81mm. Such scars on cylindrical (36.05mm) and conical (51.9mm) cores are typically shorter. Finally, when considering the ratio of weight to removal scars, complete wedge shaped cores average higher ratio (30.2) than conical cores (13.6).

Wedge shaped cores were initially classified according to the patterning of removal scars observed on the core face. Such cores at Topper come in two forms. These include cores that have blade removal scars struck from two platforms (bi-directional), and cores having such removals struck from multiple platforms. In all, three complete wedge cores have bi-directional scar patterns, while an additional three cores have multi-directional scars. There are no cores with uni-directional removal scars for this class. Complete bi-directional wedge cores have removal scars that were struck from each end, one end and one side, or one end and the face. The removal scar counts on these cores range from eight to twelve. Complete multi-directional wedge shaped cores have at least three platforms from which multiple blades were struck at

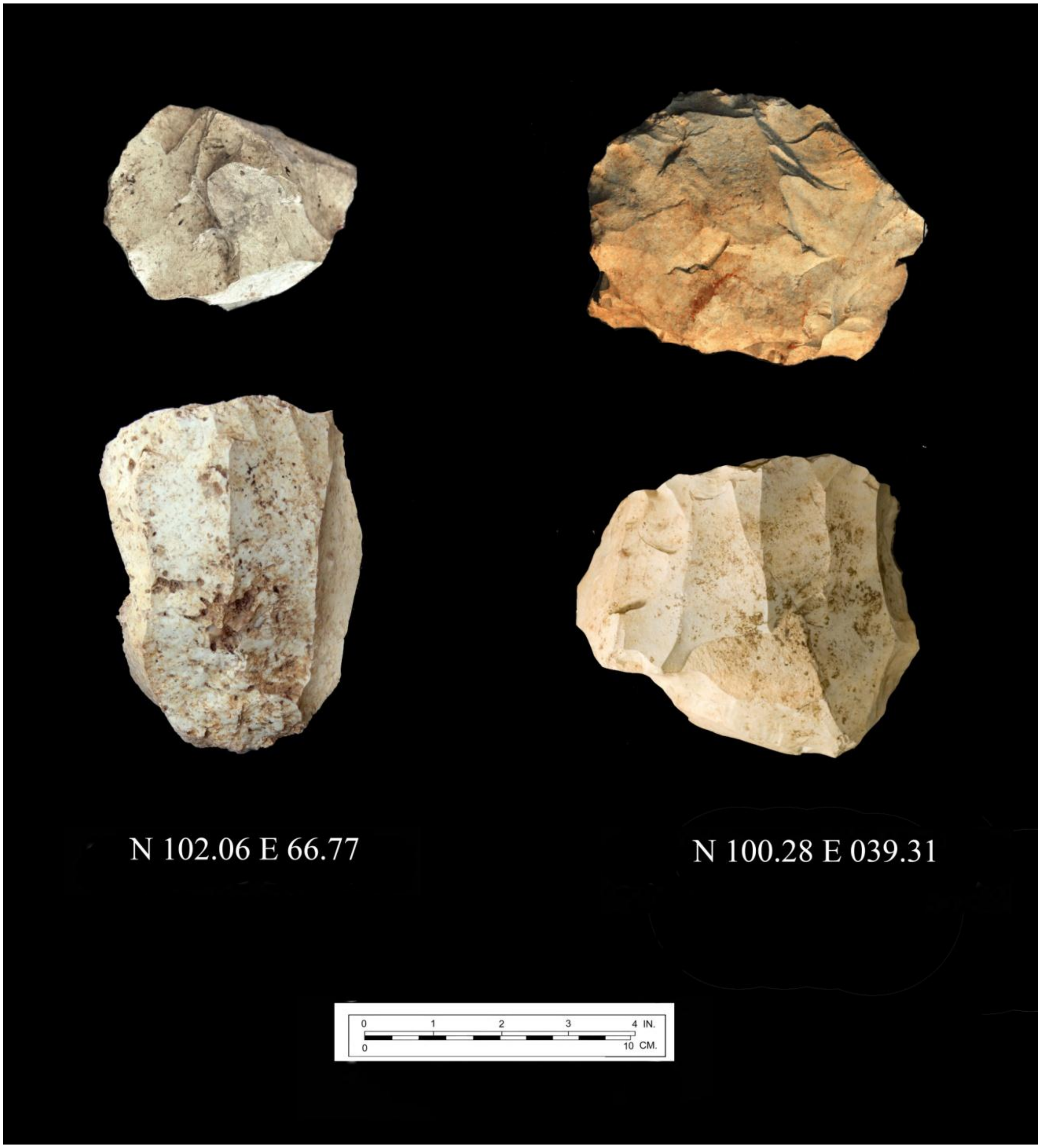

Figure 51. Topper wedge shaped cores.

parallel, perpendicular, and opposing directions. At Topper, blade removals on such cores appear to have been struck from an end, as well as a side or face. Scar counts are higher on multi-directional forms (Refer to Table 43). In most cases, Topper wedge shaped cores were produced by the initial removal of a series of blades from a single platform. When blades of the desired form could no longer successfully be removed, the core was rotated, usually 90º, but occasionally 180º on its axis, upon which a

Table 43. Mean morphological attributes for all cores.

	Weight(g)	Scars	L/RS	W/RS
Generalized	274.09	13.54	44.59	19.34
Flake	398.32	12.42	58.32	28.08
Cylindrical	322.23	19	36.05	16.95
Conical	198.2	15	51.91	11.96
Wedge	277.36	10.58	70.52	25.98

Figure 52. Two Topper core fragments that refit

second series of blades was detached. Often, this second series of blades was removed at an angle perpendicular, and sometimes diagonal to the initial striking platform, using the remnant scars from the first set of blades as a new platform. Wedge cores discarded at this stage form the bi-directional variety. However, this pattern of rotation could have been repeated a number of times, utilizing as many as four core platform surfaces. Blades struck in this manner form the multi-directional class.

This manufacture trajectory results in cores whose morphology may be described as hoof shaped (Goodyear 2005).

A total of five wedge cores are classified as core fragments. Each of these has at least a partial striking platform from which blades were struck. In many cases, two or more platforms are missing from these cores. However, blade core fragments have remnant scars that do not retain a negative bulb, suggesting that blades were detached from a previous platform at some point earlier in the manufacture trajectory. In such cases, scars are flat rather than curved, and do not exhibit a negative bulb or a platform conchoidal scar. Blade core fragments may be differentiated from multi-directional cores by the presence of 2 or more parallel removal scars on the core face detached from at least a partial platform.

Finally, two wedge core fragments were found that refit (Figure 52). This core has two platforms, one on each end, and from which bi-directional blades were detached. Both platforms are plain, and do not exhibit evidence of preparation. One end has six remnant scars, four of which still retain negative bulbs at the platform core face juncture. The platform at the opposing end has eight scars, three of which retain negative bulbs. A total of four scars terminate in steps or hinges. This core appears to have broken horizontally, along the medial section of the core, and across multiple remnant scars. This suggests that the core fractured at some point after blade detachment, as remnant scars from a single detached blade are present on each refitted piece.

In summary, formalized blade cores at Topper can be cylindrical, conical or wedge in shape. The cylindrical core has two opposing platforms, only one of which has been used for the detachment of blades. Conical cores, like the cylindrical core, are short, wide, and discarded at late stages if not exhausted. These cores have low weight to blade removal scar ratios. Conical cores have multiple, often overlapping uni-directional removal scars struck from a single acute platform. Wedge shaped cores have two or more platforms from which bi-directional or multi-directional removal scars were struck. In addition, they have higher platform angles, are narrower, and generally longer and lighter than conical cores.

Core Tablet Flakes

In an effort to better understand the approaches employed in blade manufacture at the Topper site, a sample of blade production debitage was examined. A total of twelve artifacts have previously been identified as core tablet removal flakes. The presence of core tablets at a site is strong evidence of blade manufacture. However, one must use caution about inferring that the presence of core tablets reflects the production of numerous blades. At the Pavo Real site in Texas for example (Collins et al. 2003), multiple core tablets have been found to refit to a single blade core, without a single blade detachment occurring between tablet removals. This outcome likely reflects the production of unsatisfactory angles between the core face and platform upon the removal of each tablet. In this instance, tablets were repeatedly removed from the core until a satisfactory angle was produced that would allow a successful blade detachment. This behavior reflects a highly specialized technology; one geared toward the production of a specific desired outcome.

All of the artifacts initially identified as core tablet flakes at Topper exhibit a cortical exterior surface. This evidence implies that these flakes were detached during initial and early stages of the reduction process, as opposed to resulting from core rejuvenation and error recovery. Because flake removals are not present along the surface of these flakes, it is difficult to determine if they were produced as a result of blade manufacture by some other reductive approach. The absence of interior core tablet flakes recovered at the site to date suggests that this method of core preparation *may* not have been utilized onsite. Rather, reduction may have placed more emphasis on alternative methods of blade production such as core rotation.

Core Reduction

In this section core reduction at Topper is examined, with emphasis given to quantifying specific attributes that can inform on reduction intensity, and the extent to which core reduction was carried out onsite. Here, measures of cortex are explored, as are the quantity and condition of platforms and removal scars on the core face, and finally the weight to removal scar ratio. These attributes reflect processes of blade production, and, with replication, one can predict the attributes that distinguish such production from that of informal flake production. Refer to Appendix III and IV for core attributes.

For this analysis, each core was examined, noting the presence or absence of cortex on the exterior surface of the core. It was found that cortex is present on at least one core from each class. However, the percentage of artifacts that retain cortex varies for each class. For example, 71% of the generalized cores retain at least some cortex on the core exterior. All flake cores were found to exhibit cortex. This pattern does not hold true for formalized blade cores. Cortex is found on a much lower percentage (58%) of blade cores than on less formalized cores. However, no blade core is predominantly (greater than 50%) covered with cortex. Finally, the blade cores without cortex are on average smaller and lighter than cores that do exhibit cortex (Refer to Appendix III and IV). These findings, when considered together, strongly indicate that blade cores at Topper were reduced to a greater extent prior to discard than the generalized or flake cores. In addition to measures of cortex, the number and condition of removal scars for each class of core was recorded, and are presented in Table 43. The results show that informal cores are typically heavy, and have numerous short removal scars compared to formalized cores.

Topper wedge cores exhibit the fewest, but also the longest removal scars on the core face when compared to other core forms. However, such cores also have slightly higher weight to removal scar ratios. If one assumes that scar count and weight to removal scar ratio are attributes that can be used to measure core reduction, then the findings of this study indicate that wedge cores were discarded at earlier stages of reduction than conical or cylindrical core forms. In order to evaluate blade core reduction more thoroughly, and to determine if the differences observed were statistically significant, a T-test was conducted to compare the morphological attributes of wedge, conical and cylindrical cores (Table 44). Given the confidence interval, the results of this test demonstrate a statistically significant difference in scar count and mean scar length when wedge cores are compared to conical and cylindrical cores. However, there is no statistically significant difference when one considers attributes of weight and weight to removal scar ratio.

In addition to scar morphology, scar condition appears to vary according to core class. For example, wedge cores generally have few blade scars that end in hinge or step terminations. Some blade removals from wedge cores may have been struck from platforms that no longer exist, or have been rejuvenated, and due to continued blade manufacture, only the distal terminations from such removals still remain. In contrast, conical and cylindrical cores have numerous scars that terminate in hinges or steps. Such scars are typically short (<5 mm), and occur in clusters at the core platform face juncture. This pattern likely represents repeated failed attempts at blade removal, and subsequent core rejection and discard.. The percentage of scars that terminate in steps or hinges should be expected to increase with continued reduction and as cores are reduced in size (Clarkson 2007).

The platforms of all formalized blade cores were examined. A number of patterns were identified in this analysis. First, wedge cores typically have multiple small platforms. The platforms of cylindrical and conical blades cores are greater in size (Table 45). Next, when platform angle is considered, conical and cylindrical cores have more acute platform angles than wedge cores. Finally, conchoidal platform scars are on average fewer in number for wedge cores. In order to model blade core reduction intensity at Topper, variation in attributes were examined according to the presence or absence of exterior surface cortex. To predict sequences of reduction, a number of assumptions were formulated. First, it is assumed that if removals are detached systematically around the circumference of the core platform, then as reduction intensifies, cores will exhibit less cortex, and higher exterior scar counts. Because some researchers have shown that exterior cortex amount alone is not an adequate indicator of reduction, I also use the number of scars on the exterior surface as a second line of evidence in modeling core reduction intensity at Topper. It is also assumed that platform size and core size will decrease as reduction progresses. Finally, hinge and step terminations, as well as conchoidal scars should be more numerous on cores from later stages of reduction, as rejuvenation becomes more difficult as core size decreases. Mean attributes for each attribute category are presented in Table 46. As expected, the mean core weights are less for cores without cortex. Interestingly, more hinge and step terminations, as well as conchoidal platform scars were observed on cores that still retain cortex. The abundance of such scars on presumed early stage cores may be a sign of errors encountered upon the attempted removal of decortication and secondary reduction blades. In summary, the results of the core analysis find that generalized cores are relatively large, have numerous short removal scars and retain high percentages of cortex. Many of these attributes are consistent with initial or early stages of core reduction. Formalized blade cores represent later stages of reduction, often having little or no cortex present on the core face. Conical and cylindrical blade cores are few in number, small, light, and exhausted; occasionally so much so that some remnant scars begin to take the form of blade-like flakes rather than technological blade scars. Wedge shaped cores have multiple plain, faceted or multi-faceted platforms from which a few relatively long blades were struck Many of these cores appear to have been discarded at earlier stages in the manufacture sequence than conical cores.

Table 44. T-test comparing morphological attributes of Formalized blade cores.

	Wedge Cores		Conical/Cylindrical Cores			
	Mean	SD.	Mean	SD.	T-statistic	Probability
Scars	10.58	5.0535	16.33	2.5166	1.8745	0.0836
Length/RS	70.52	21.7802	46.62	10.5007	1.8102	0.0934
Weight	277.36	271.6520	239.543	72.1872	0.2325	0.8200
Weight/RS	25.98	18.5905	13.622	3.2955	1.1125	0.2878

$\alpha = 0.1$ Two tailed test. SD. = Standard deviation

Table 45. Mean attributes of the core platform and core face.

Core Attribute	Wedge		Conical/Cylindrical	
	Mean	SD.	Mean	SD.
Platform Diameter (mm)	45.05	22.0525	76.53	13.5092
Hinge/Step Term. (no.)	3.08	3.2322	6.0	1.0000
Platform Angle	69.44	10.9100	59.17	7.3598
Conchoidal scars (no.)	3.18	2.7136	4.67	2.0817

Table 46. Core attributes by cortical class for formalized blade cores.

	Cortex				No Cortex			
	Scar count	Weight	Hinge term.	Con. Scars	Scar count	Weight	Hinge term.	Con. Scars
Blade Cores	12.55	265.3	3.8	2.8	10.5	116.96	1.7	2.6

Con.= Conchoidal; Term = Termination. Values represent the mean for each category

Chapter VII

DISCUSSION AND INTERPRETATION OF RESULTS

This study examines whether a sample of the artifacts previously identified as Clovis blades at the Topper Site meet the technological definition of blade manufacture, and if so, what the nature of blade production technology is at the site. The data in this study are a sample of artifacts recovered from multiple locations of the site. This sample was taken from strata known to contain associated diagnostic Clovis artifacts. Based on the attributes examined, results show that blades are present at Topper, although artifacts that share attributes consistent with blade-like flakes also occur from the sample examined. The blades with the highest summed attribute values are most often complete interior blades, generally having plain platform remnants and possessing multiple (2+) parallel uni-directional removal scars on the exterior surface. Such blades are the product of blade core reduction, and are detached from one of three types of cores; wedge, and less frequently cores that are conical and cylindrical in shape. The technological attributes observed for the majority of blades are products of later stages of reduction, and exhibit little or no exterior cortex. Finally, the large number of broken blade proximal ends, often having prepared platforms, and terminations that step or hinge, likely reflects failed attempts at blade detachment during the manufacture process (Steffy and Goodyear 2006).

The Topper blade assemblage was compared to other known Clovis blade assemblages from outside the region. This comparison revealed a number of interesting patterns, most notably the statistically shorter maximum lengths, the greater platform sizes and straighter blades found at Topper. These attributes may be explained as resulting from specific manufacture techniques (e.g. Hard hammer, soft hammer percussion) chosen in response to raw material type, quality, and morphology that was available to prehistoric groups of the region.

Blade Production Sequence

The results of this analysis demonstrate that the Topper blade assemblage was derived from all stages of reduction, employing various percussion techniques based on stage, thus resulting in a number of different classes of blades and cores. Blades were initially separated by the presence and amount of cortex observed on the exterior surface, and number of exterior removal scars. Cortical classes include primary decortication, secondary, and interior blades, as well as two specialized forms referred to as crested blades and corner blades. Each class was subsequently sub-divided according to its form, the categories of which include parallel and irregular. By documenting variation in the attributes and conditions of artifacts from each class, it is possible to model stages involved in blade production at Topper. Stages include raw material acquisition and core preparation, initial decortication and primary reduction, secondary reduction, and finally interior reduction, and core discard. In some cases, core discard may have occurred if detachments suitable for use had already been obtained. Each stage in the production process for each core class is explained in detail below.

Decisions in blade manufacture began with the selection and acquisition of raw material. The raw material source at Topper is Allendale chert, a variety of Coastal Plain nodular chert, and of all artifacts examined for this analysis, only a single blade medial segment was found to be a product of non-local material. This artifact was produced from high quality rhyolite, whose nearest known source exists in the Central Piedmont of North Carolina (Goodyear et al. 2009). This discovery demonstrates that blades were part of a personal, transported toolkit. As such, raw material availability and properties of raw material size, shape, and quality play a significant role in the types of tools that are capable of being produced, as well as the methods chosen for manufacture. For example, if a selected piece contains material flaws, successful blade production is inhibited if not impossible, and may require multiple episodes of rejuvenation and core maintenance to work around such problems. In some instances, pieces selected for tool manufacture may have initially appeared to be of adequate quality and suitable for such use. However, the presence of poor quality material may not have become evident until later stages of reduction. In such instances, it may have become necessary to discard the piece in favor of more homogenous material.

Properties of available raw material conditioned the manufacture of blades at Topper. The manufacture approach (i.e. flake production, blade production, biface production) identified from the artifact assemblage may be influenced more so by raw material size, shape quality, and presence of existing cortex than by the intended end-product. With this idea in mind, though blade manufacture may be the goal of core reduction, raw material of poor quality can preclude such production, resulting instead in unintended flakes or blade-like flakes. Likewise, raw material form plays a significant role in blade manufacture. At Topper, raw material is available as terrestrial nodular cobbles and boulders that form the chert outcropping, as well as nodular, alluvial chert cobbles from the river bed. Such forms may require different techniques of reduction in the initial manufacture of blades than raw material that is tabular or blocky in form. The possibility that variation exists in approaches to blade manufacture as a consequence of raw material morphology is real and will be addressed shortly.

Once raw material is selected, the next step in blade manufacture is core preparation. A number of core types were recovered at Topper, and initial preparation of these cores was accomplished in one of two ways. First, if a natural platform was not present, one was created by removing one end of the nodule. In contrast, some pieces selected for reduction have preexisting surfaces with angles great enough to allow for the detachment of a blade without the removal of an end. For generalized cores, core preparation was informal in nature, and often absent. Initial removals on these cores were struck indiscriminately from multiple angles, often resulting in flakes or blade-like flakes as opposed to blades. These cores predominantly have greater weights as well as greater ratios of weight to removal scars than do formalized cylindrical and conical blade cores, suggesting that they were often discarded during initial or early stages in the manufacture process. Moreover, 35 of the 51 (69%) artifacts identified as generalized cores retain cortex, further supporting this view. Some generalized cores reflect raw material testing rather than actual tool manufacture, a finding that is common for quarries. An inspection of the raw material of these specimens reveals many to be of poor quality, and to contain numerous inclusions. With such an abundance of available raw material to select from, once reduction problems were encountered, pieces were likely abandoned in favor of more homogenous material better suited for blade manufacture.

Three classes of formalized blade cores were identified, cylindrical, conical and wedge shaped. Cylindrical and conical cores are far less common, and all appear to be exhausted. At Topper, preparation of cylindrical and conical cores began with the removal of a single end, followed by the preparation and detachment of an initial blade. No core from this class was found to have a cortical platform. Decortication blades, however, are rare at Topper, as defined by parallel margins, triangular cross sections, platform angles greater than 60 degrees, and ratios of proximal/distal thickness that are skewed to the distal termination. Moreover, primary blades typically exhibit a number of small removal scars at the proximal end that reflect core preparation prior to detachment. However, at Topper, the morphological properties of raw material may not have been suitable for the detachment of such blades. For example, if proper angles are absent, blade detachment is difficult. It may have been necessary therefore, to create an artificial ridge or crest prior to striking a blade from the core. Crested blades are present at Topper. These blades exhibit flaking patterns from the blade margins. Such flaking likely served to strengthen a ridge, and allowed detachment of more regular parallel blades. The scarcity of decortication blades at Topper may have been a result of such flaking and would have led to the production of crested blades.

On conical cores, secondary blades were detached in a series about the core face, frequently following an established ridge produced from the previous removal. Through this method of reduction, one lateral margin on the first series of blades retains cortex, while the other margin reflects the negative scar left from the previous blade detachment. This first series of blades is secondary until all cortical material is removed (Dickens 2005). At Topper, a single conical core (N 159 E 77) retains cortex on the core face indicating that reduction ceased prior to the removal of all cortical material.

At Topper, there is evidence of core rejuvenation on conical cores. Such cores have conchoidal scars along the platform-core face juncture. In addition, hinge and step fractures frequently build up along this juncture as well, indicating the necessity for core rejuvenation. The existence of single multi-faceted platforms on some of these cores is evidence of platform preparation and rejuvenation. Preparation of these cores was achieved by the removal of flakes, first to rejuvenate the core platform surface and second to form a prominence at the platform-core face juncture. Flake scars on cylindrical or conical core platforms (Figure 53) were formed through the removal of one or multiple core tablet flakes, producing multiple concavities on the newly created platform. Such flakes are referred to as sequent flakes (Dickens 2005, 2008), and appear winged-shaped. These flakes have been identified at the Gault site in Texas, but to date, no such flakes have been identified at Topper; only the remnant scars from their removal are present on platform surfaces. Occasionally, the lateral margins of these flake scars formed prominent protrusions along the core platform/face juncture. Once isolated through additional flaking, such protrusions provided added control over subsequent interior blade detachments.

An attribute found on conical cores is the tapered distal end (Figure 54). On these cores, the end opposite to the platform usually tapers, forming a point at the distal terminus. This morphology is produced as a result of successive blade detachments from a single platform. The presence of lateral flaking at the distal end results in cores whose morphology appears cylindrical rather than conical in shape. While there is no evidence for the use of the distal end as a platform to detach blades, such flaking may have been undertaken to straighten the face of the core, and to allow detachment of blades that are less curved. Ultimately, continued reduction of cylindrical and conical cores rendered them too small, or having too many structural flaws for the successful removal of additional blades. At such point, these cores would have been discarded in favor of larger specimens, and material of higher quality. Blades detached from wedge shaped cores represent an alternative reduction trajectory to those produced from cylindrical or conical cores. Such a trajectory appears to have been the method of choice at Topper, although specific techniques employed in the reduction sequence result in a core morphology that differs from the accepted definition provided by Collins (1999a).

Figure 55 illustrates the sequence of blade core reduction that results in the production of wedge cores at Topper. Wedge cores were initially prepared by the removal of a single end, followed by the detachment of a decortication blade. Subsequent secondary blades (usually two to six) were flaked in a parallel fashion along a single core face, but typically do not encircle the entire core. When blades of the desired form could no longer successfully be removed, the core was rotated, frequently at 90 degree but sometimes at 180 degree angles, and blade production continued, with detachments struck from a second platform. Such platforms can occur at opposing ends, or at right angles 90 degrees to the initial striking platform surface. This reductive approach serves to maximize the potential output of a given piece of raw material. In some cases, the second series of blades was removed, using the original core face as the new core platform, with detachments struck along the old core platform. This discovery may indicate a time lag in core reduction between initial and later series of reduction episodes. In other examples, rather than detaching a second series of blades from a new core platform, the old platform was simply flaked in an attempt to create an improved striking surface for subsequent blade detachments. In most examples of wedge shaped cores at Topper, only three or four removals were detached from a given core face prior to the selection and preparation of a new platform. This method of detachment followed by rotation could be employed multiple times, ultimately creating as many as four platform surfaces.

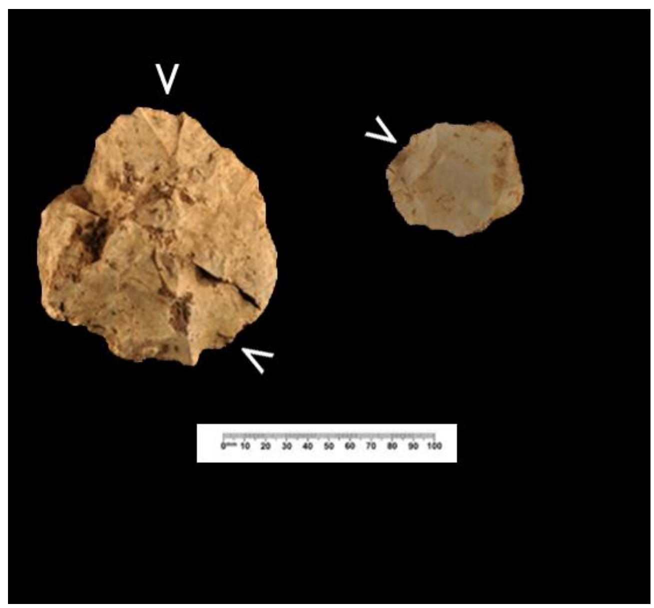

Figure 53.

Figure showing location of flake scars on cylindrical and conical core platforms.

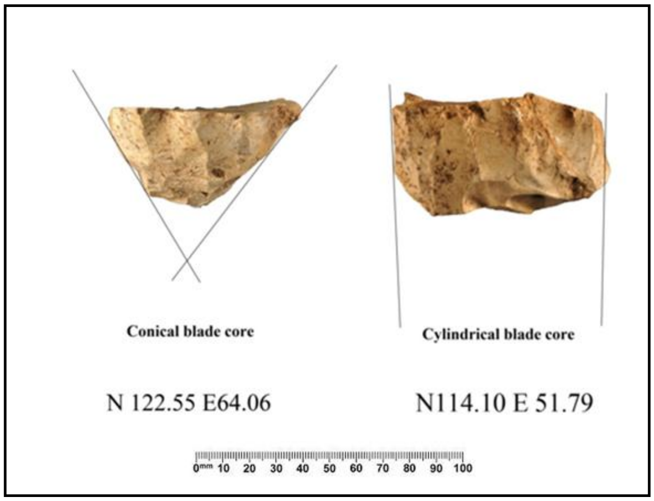

Figure 54. Illustration depicting conical and cylindrical cores from the Topper Site. Note the tapered distal end on the conical core compared to the cylindrical core at right.

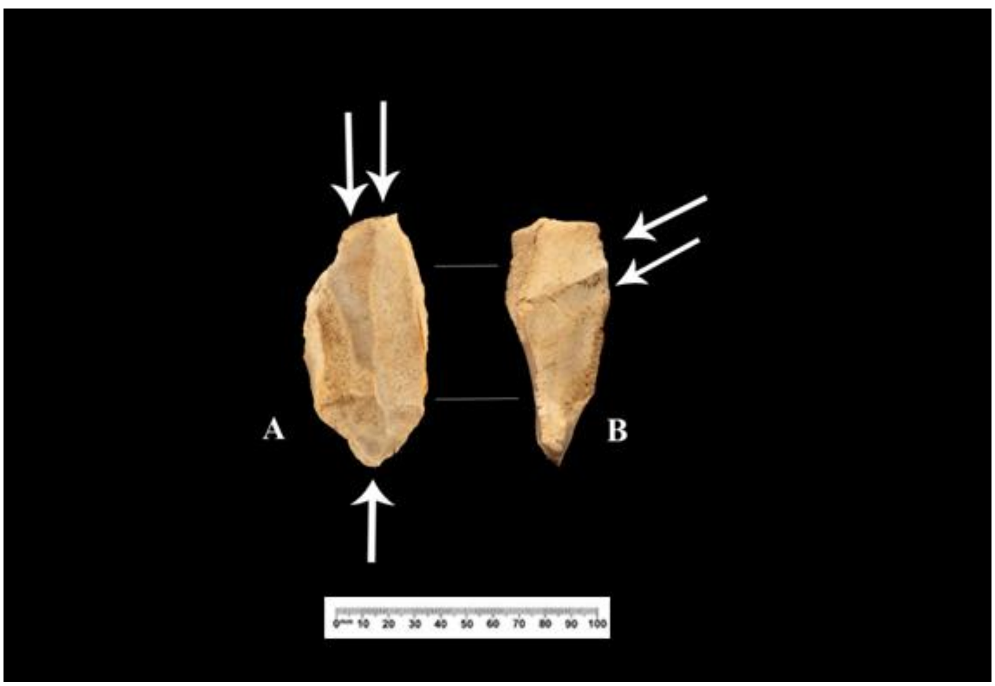

Figure 55. Depiction showing method of wedge-shape blade core production at Topper. A shows a series of blade detachments. B shows blade distal termination scars detached at an angle perpendicular to series A. Series B blades were detached at a point earlier in the reduction sequence than series A, which has removed evidence of the original striking platform.

Table 47. Attributes of Topper crested blades.

L (mm)	W (mm)	I/C	C/S	Scars	Cortex	Stage
75.31	33	3.76	Triangular	4	Present	Secondary
100.1	40.21	7.86	Triangular	4	Present	Secondary
73.18	33.67	11.43	Triangular	6	Present	Secondary
55.85	18.82	6.1	Triangular	2	Present	Secondary
114.9	36.02	14.45	Triangular	17	Present	Secondary
63.34	27.51	6.17	Triangular	3	Present	Secondary
83.82	34.19	0	Triangular	8	Present	Secondary
83.76	21.16	2.99	Triangular	8	Absent	Interior
95.22	28.4	12.39	Triangular	5	Absent	Interior
52.08	22.42	10.86	Triangular	5	Absent	Interior

I/C = Index of curvature; C/S = Cross section; Scars = number of scars

Due to continued rotation, surfaces previously used as platforms are sometimes overlain by more recent removals, creating scar patterns that are not only bi-directional, but that are also perpendicular. This method of core reduction often results in scars that do not retain a negative bulb at the proximal end. Eventually, only the medial or distal terminations of such scars remain, making interpretations of manufacture technique difficult. An examination of the debitage found that interior core tablet removals are absent at Topper. However, twelve cortical flakes were identified that resemble core tops. Though they cannot be distinguished from flake production, such flakes may be initial removals from the core to prepare a platform for subsequent blade detachments. Two specialized forms of blades were identified at Topper. These include crested blades (Table 47), and corner removal blades. These forms were found in much lower percentages (5%) at the site than were secondary or interior reduction blades. Crested blades are usually detached as a means to guide future blade removals, but can also serve as a technique to straighten the margins throughout the production sequence (Dickens 2005). For this analysis, it was not possible to determine whether the Topper crested blades were detached from cylindrical, conical, or from wedge shaped cores. However, most examples are long, often exceeding 70mm in length, are triangular in cross section, and have strongly curved profiles. Cylindrical or conical cores in their present form at Topper do not have remnant removal scars of such length to suggest that they were utilized in the production of crested blades. In addition, the remnant scars on these cores are straight rather than curved. However, these findings do not mean that crested blades were not detached from cylindrical or conical cores during earlier sequences of the manufacture process. The length, great curvature, and broad platforms present in these blade forms would seem to suggest that they were detached from larger nodules, struck directly with a broad ended implement, and with the core secured loosely in hand. While crested blades are often associated with early sequences of core reduction, they may be detached at any point in the manufacture trajectory. They represent blade core preparation.

At Topper, 60% of all crested blades are from early to middle stages of reduction, meaning they have at least some cortex on the exterior surface, and have triangular as opposed to trapezoidal cross-sections. Interior crested blades may have been detached as part of the core rejuvenation process. All but a single crested blade have 3 or more bifacially flaked scars of previous removals that form a ridge along the long axis of the blade. Flaking can occur in a number of ways. This includes those struck uni-directionally from a single margin, bi-directionally from two margins, multi-directionally from a single margin, or multi-directionally from two or more margins. In addition, some were flaked using a combination of the methods noted above. The variety of flaking angles and directions evident on the exterior surfaces of crested blades from Topper may indicate attempts at working around inclusions in the raw material, error recovery, or the preparation of a ridge for subsequent blade removals to follow.

The distribution of crested blades onsite is low compared to other blade forms. One may assume, according to this pattern that crested blades were not a primary component of the blade manufacture sequence at the site. However, upon the creation of a ridge for blade propagation to follow, subsequent detachments would have followed the “ridges” produced at the apex of each removal scar. Only upon encountering errors or inclusions in the raw material would it have been necessary to create additional crested blades. The absence of attribute data on crested blades from other sites in the region makes comparison of this artifact form difficult.

Corner blades, as the name implies, were struck from the corner of a core, or where two sides meet. At Topper, such blades are most often complete, have triangular cross-sections, and platform remnants that are plain or faceted. Like crested blades, corner blades represent core preparation and rejuvenation. However, they may be a product of any stage of the manufacture process. Unlike crested blades, the corner blades are short and straight. All terminate in hinges or steps as opposed to feather terminations, indicating that many may have been mis-struck detachments or for the removal of excess material in the rejuvenation process. In addition, corner blades exhibit increased distal thickening, and typically do not exhibit lateral flaking to form a ridge. These blades are shorter than the other blade classes, are typically parallel, and have uni-directional removal scars as opposed to bi-directional scars. Based on these attributes, corner blades at Topper appear to be consistent with conical core production rather than wedge shaped. However, based on such a small sample size future analysis on additional blades of this form, if present, are needed to substantiate these findings.

Manufacture Technique

The techniques used in Clovis blade manufacture are thought to include either direct hard or soft hammer percussion, or indirect percussion with the aid of a punch. Moreover, the method by which an objective piece (core) is held or immobilized is also critical in manufacture technique. For this analysis, the attributes of bulbar definition, platform remnant size, and index of curvature were used to infer manufacture technique.

According to Collins (1999a), blades having small platform remnants and diffuse bulbs of force are a likely product of soft hammer indirect percussion. At Topper, most blades from the sample examined have large platform remnants, greater than 5mm in diameter, diffuse or flat bulbs of force, and edge profiles that are relatively straight. One of the most distinctive characteristics of Topper Clovis blades is the lack of salient or pronounced bulbs of force, which are most often associated with direct hard hammer core reduction. The few blades with pronounced bulbs at Topper (N = 3) all end in hinge terminations, and two examples have irregular margins. Diffuse bulbs characterize the vast majority of the Topper blade assemblage (N = 254). Antler billets and other soft hammer percussors commonly associated with such blade production are absent at Topper. However, the absence of such percussors in the archaeological record at Topper may have been a result of the nature of preservation of organic material at the site. Hard hammers in the form of quartzite pebbles and cobbles have been recovered intermittently from Clovis deposits throughout the site. These pebbles often exhibit evidence of battering on one or both ends. Occasionally such cobbles are broken or split. In an examination of lithic material recovered from the southern firebreak excavation, Miller (2007) found a total of 27 quartzite cobbles, 17 of which show evidence of battering. In addition to quartzite, chert nodules of varying shapes and sizes are also present at the quarry. These materials may have been suitable as hard hammer percussors, although an experimental test found them to quickly fracture and crush, and thus were likely inadequate for such uses long-term.

The degree of curvature that a blade exhibits is considered to be a function of how the core was held during blade detachment, striking implement, and force application. For example, blades that are curved in profile are thought to occur as a result of core movement as the blade is being struck (Bordes and Crabtree 1969; Collins, 1999a). This often occurs if the core is secured loosely. On the other hand, a core that is held in place or immobilized during blade detachment, and struck directly, will result in blades that are straight in profile. By resting the objective piece on a level surface, combined with some means of securing it, straight blades similar to those evident in Old World Upper Paleolithic assemblages may be produced (Bordes and Crabtree 1969; Boldurian and Hoffman 2009). Blades of such form make up the majority of the Topper interior blade assemblage. However, studies have shown that force application, indirect versus direct, can also influence blade curvature. Blades detached through indirect percussion with the aid of a punch, though secured firmly with a vice or clamp, often result in blades that are curved.

In an experimental study geared toward identifying manufacture technique in Clovis blade production, Boldurian and Hoffman (2009) found four attributes (raw material type and quality, manufacture technique, force application, and core hold) that influence the degree of curvature a given blade detachment will exhibit. The results of this study are presented in Table 48. Based on their findings, it would appear that blades with the greatest curvature are a product of indirect percussion. Blades struck directly, yet held securely exhibit less curvature. Finally, raw material type has an influence on blade curvature. It is questionable whether a blade detached

Table 48. Blades by Mode and Technique of Manufacture from Experimental Study.

Material	Manufacture Mode	Force Application	Core Hold	I/C
Glass Butte Obsidian	Soft Hammer	Indirect Percussion	Firmly Clamped Between Knees	9.63
Edwards Chert	Hard Hammer	Direct Freehand Percussion	Hand Gripped Firmly Knee Rest	5.32
Horsehead Mountain Obsidian	Soft Hammer	Direct Freehand Percussion	Hand Gripped Loosely	8.26

Table Adapted from Boldurian and Hoffman 2009. I/C refers to Index of Curvature.

Table 49. Reduction stage by mean length and Index of curvature for complete Topper blades.

	Mean Blade Length (mm)	Mean Index of Curvature
Cortical Class		
Primary Decortication	87.8	6.36
Secondary	74.75	4.72
Interior	57.79	3.7

indirectly from a chert core would exhibit a similar outcome in terms of curvature as a blade detached indirectly from an obsidian core.

At Topper, a combination of soft and hard hammer techniques were likely used in the production of blades, with changes occurring as the manufacture trajectory progressed. Here, early stage blades exhibit higher indexes of curvature than do middle to late stage blades (Table 49). In addition, most blades having crushed platform remnants (an attribute frequently associated with hard hammer percussion) were found to be products of early stages of manufacture. Finally, Topper blades exhibit wide, thick platform remnants and diffuse bulbs of force, evidence of direct free-hand percussion. Based on Boldurian and Hoffman's results, the findings at Topper would seem to indicate that initial stages of blade manufacture utilized soft or hard hammer direct percussion, with the objective piece held loosely.

Chert cobbles initially selected for reduction not only would be more bulky and difficult to secure, but would also present the knapper with more resistance, and require added force for blade propagation to occur. Moreover, the rounded exterior surfaces and irregular natural striking platforms present on selected cobbles often result in decortication blades that are curved. In contrast, during later stages of manufacture, and once acute platform/core face angles have been produced, blade curvature tends to reduce. Later stages of blade manufacture likely saw a move to only soft hammer direct percussion, with the objective piece held more firmly in place, and hence also creating blades that are straighter in profile.

The interior blades at Topper generally do not exhibit crushed platform remnants, have lower angles of applied force, and are less curved in profile than decortication and secondary blades. These attributes indicate soft hammer direct percussion, with the core held securely. Small, ground platform remnants are typically associated with indirect percussion. At Topper platform remnants are generally wide and thick, and bulbs of force are almost always diffuse suggesting that indirect percussion was not a method employed at Topper.

It should be noted that properties of raw material also likely played a factor in the technique(s) chosen in blade manufacture at Topper, as well as the resulting attributes of detached blades. For example, in Boldurian and Hoffman's (2009) experimental study, the raw material of choice for blade production included chert and obsidian taken from three separate locales. At Topper, raw material is available at the site in the form of Coastal Plain chert. Blades produced from this form of chert at the site can occasionally exhibit inclusions, evidence of raw material of lesser quality. Interestingly, of the cores examined in this analysis, only four (5%) exhibit inclusions or are of poor quality material. Of these, all were identified as generalized flake cores. Future experimental studies using Coastal Plain Allendale chert need to be undertaken in order to better understand the methods by which blade production occurred at Topper.

Apart from percussion, another technique often employed in lithic manufacture is the grinding or abrasion of the core platform/face juncture. This action strengthens the platform and enables uniform, more regular detachments. This form of platform preparation is often used for various approaches to lithic production, including blade manufacture. If struck properly, detached blades that are prepared in such a fashion are often regular in form. At Topper, the practice of platform grinding is most evident on interior blades, and blade proximal fragments. Very few complete blades (2%) exhibit platform grinding, though when present, such grinding typically overlaps faceted or multifaceted platforms. The presence of grinding is not found on the modified blades examined. However, it is possible that such examples, along with complete forms most desired were transported offsite, and are no longer present at the site.

Blade-Like Flakes

Blade-like flakes were also identified among the Topper lithic assemblage, though in smaller numbers than found for blades. The presence of such flakes onsite may be attributed to a number of factors. First, unlike blades, Topper blade-like flakes were frequently found to be consistent with multiple manufacture approaches. These approaches include biface, flake, and generalized core reduction.

At Topper, the blade-like flakes produced as a result of biface manufacture frequently occur during early sequences in the reduction process. Such flakes typically have cortex, are irregular in form, and are curved. Examples of interior blade-like flakes are predominantly a by-product of flake and generalized core production. These flakes are shorter than primary or secondary blade-like flakes. The presence of a number of flake cores at Topper that also have prior detachment scars that appear blade-like support the possibility that such cores may have been utilized to create such flakes. There is a possibility that some blade-like flakes at Topper may have been a by-product of the blade manufacture process. However, these flakes are more likely the result of core rejuvenation, error recovery flakes, or mis-struck removals, than the result of intentionally struck blades

Topper and its Role in Technological Organization

The most intriguing discovery of this analysis is the low percentage of blades at Topper that exhibit evidence of modification. In total, only 16 of 250 of the identified blades exhibit some form of modification. In most cases, modification consists of bilateral or unilateral retouch. The discovery of so few modified blades at the site raises questions concerning technological organization, and involves the relationship(s) between Clovis blade production, mobility, and settlement subsistence patterns in the region.

In this section, I seek to interpret what the presence of un-modified blades at Topper represents. I offer three models.

1. Blades were manufactured at Topper to be used unmodified onsite. This manufacture strategy reflects a technology geared toward expedient tool production. In this model, detached blades would have been used as is, with little consideration or effort given to time expended in manufacture. Such blades would exhibit little evidence for platform preparation. The lack of modified blades onsite would also indicate that blades did not come to the site as part of the Clovis toolkit for discard.

2. The Topper blade assemblage is largely composed of unsuccessful detachments or discards of the manufacture process. In this model, blades would have been manufactured onsite, with suitable products ultimately transported for use elsewhere. Such reductive approaches could also account for any variation found to exist between some technological attributes of Topper Clovis blades (those produced at the quarry) and those attributes that conform to the traditional description of a blade as defined by Collins (1999a), a sample largely taken from a number of different types of sites. This strategy of lithic production reflects a curated approach to technological organization.

3. Cores were prepared and reduced to manageable forms at the quarry, to be transported elsewhere for blade production as needed. The principal argument for this model proposes that it is less costly of time and energy to possess transportable sources of raw material that can serve the production of a number of tools (in this case blades), than to be in a position without such tools, and at some distance from raw material resources at the time of need. In this model, any unmodified blades recovered at Topper would represent by-products of preformed core production rather than serving as blade tools. Moreover, this strategy implies that blade curation encompassed a rather broad range of mobility, with a return trip to the raw material source for replenishment not expected for some period.

Before I examine these hypotheses as they relate to strategies of blade manufacture and technological organization at Topper, it is necessary to provide a background on other archaeological sites in the region. Blades are found in association with Clovis artifacts at a number of sites throughout the Southeast. Below is provided a discussion of Southeastern archaeological sites with known blade assemblages, and a comparison of such sites to the blade technology and technological organization present at Topper is offered.

Southeastern Clovis Sites with Blade Assemblages

Sites with identified blade assemblages in Clovis context, or of probable Clovis context include Adams in Western Kentucky (Sanders 1990), the Williamson and Cactus Hill sites in Virginia, and the Nuckolls, Sinclair, Carson Conn Short and Wells Creek Crater sites in Tennessee (Ellerbusch 2004, Broster and Norton 1996) (Figure 56). Most sites are quarry-related reduction or temporary camp locales, where lithic extraction and tool manufacture were significant activities. Assemblages are dominated by locally available raw material, and sites are generally located adjacent to or near river drainages.

Adams Site (15CH90) and Little River Clovis Complex

According to Sanders (1990), the Adams Site is a short-term intensely occupied lithic reduction and base camp located in Christian County, Kentucky. The site is part of the Little River Paleoindian Site Complex that includes a number of single component lithic workshop and habitation sites along the Little River (Gramly and Yahnig 1991; Freeman et al. 1996). Surface collections at Adams have yielded a number of tools, including blades made from locally available Hopkinsville chert, part of the St. Genevieve limestone. Though a surface collection, the site also contains diagnostic Clovis artifacts including projectile points.

The blade assemblage at Adams includes both unmodified blades as well as those made into other unifacial tools such as end and side scrapers. Gravers are also made on blades. Blade manufacture at the site made use of both nodular as well as tabular forms of chert. In addition to blades, a number of cores are present, and are considered to be a product of either block or spherical nodules (Sanders 1990). Polyhedral cores are conical in form and were used for the production of both blades and flakes. Furthermore, the purpose of blades was to serve as preforms for other tools, which in turn were utilized for "processing or domestic activities" (Sanders 1990). In addition to Adams, at least three other sites (Ezell, Boyd, and Roeder) in the general vicinity (within 2 km) also have produced blades, and blade cores, among diagnostic Clovis artifacts.

Carson-Conn Short Site (40BN190)

The Carson-Conn Short Site (CCS), located in Benton County, Tennessee, has been identified as a lithic manufacture base camp (Norton and Broster 2008). Archaeological investigations, both pedestrian surveys, as well as subsurface testing, have resulted in the discovery of blades, tools made on blades, and blade cores. These are a product of the locally available high quality Waverly chert cobbles, a form of Fort Payne chert (Broster et al. 1996). At CCS, blades were struck uni-directionally from conical, sub-conical, and wedge shaped cores. An examination of a sample of artifacts by

Figure 56. Map showing Southeastern sites with documented blade assemblages recovered in context with diagnostic Clovis artifacts.

Stanford et al. (2006) found that these blades were often removed from a single core face, often forming a hoof shaped cross section. Moreover, initial detachments were struck from cobbles having natural surfaces that served as striking platforms (Stanford et al. 2006). Morphologically, blades at CCS are long, with multiple specimens in excess of 150mm in length. An examination of curvature finds blades at CCS to vary dependent upon reduction stage, with curvature decreasing as reduction progresses. Furthermore, in addition to blades, there is evidence for the use of blade cores as tools at CCS. Interestingly, the presence of artifacts made of alternative varieties of chert is low, although raw material sources for such production may be found relatively nearby.

Nuckolls Site (40HS60)

The Nuckolls site located in the lower Tennessee River Valley of Tennessee, has been identified as a habitation and lithic manufacture site (Ellerbusch 2004). At Nuckolls, blades have been recovered as unretouched complete specimens and as laterally or terminally retouched tools (Ellerbusch 2004). Interestingly, 72% of the blades exhibit some form of modification. A technological analysis of the blade assemblage by Ellerbusch found such artifacts to reflect nearly all stages of reduction, with the possible exception of initial and decortication removals (Ellerbusch 2004). Ellerbusch suggests that chert nodules would have been initially reduced at local quarries prior to subsequent removal to the site where reduction and blade manufacture were carried out. Furthermore, blades were manufactured from a variety of locally available high quality cherts (Dover, Buffalo River, and Waverly), suggesting that production was linked to such outcrops (Ellerbusch 2004). Finally, a use-wear analysis found evidence that blades served a variety of onsite tasks. Interestingly, blade cores are absent from Nuckolls, though technological attributes of blades are similar to regional examples produced from polyhedral and wedge shaped cores (Ellerbusch 2004).

Sinclair Site (40WY111)

The Sinclair site is identified as a Clovis quarry site located along the Buffalo River in Wayne County, Tennessee (Broster and Norton 2009). Surface collections of the site have yielded complete Clovis projectile points and fluted bifaces, as well as "large blades and unifacial tools" produced from locally available Fort Payne chert (Broster and Norton 2009:35). According to Broster and Norton (2009), initial examinations at the site indicate that the primary activity at Sinclair seems to be quarrying and early stage biface and blade manufacture. Moreover, while blades are present at the site, the low quantity of unifacial tools on blades suggests that the site represents "a series of short-term visits for chert procurement and initial reduction by a portion of the social group", as opposed to longer-term occupations or base camps such as is evident at Carson-Conn Short. (Broster and Norton 2009:36).

Wells Creek Crater Site (40SW63)

The Wells Creek Crater Site is a Paleoindian site located in Stewart County, Tennessee. Surface collections of the site have revealed a number of lithic concentrations that include abundant "worked flint, chipping debris, and tools produced nearly exclusively from Ft. Payne chert, available in blocky or tabular form from within five miles of the site" (Dragoo 1973:7). Subsequent subsurface excavations revealed a number of fluted projectile points, bifacial tools, unifacial tools, and utilized flakes recovered from unstratified deposits (Dragoo 1973). Blades, blade-like flakes and cores are present at Wells Creek Crater. Blade-like flakes were found to be thick, curved, elongated flakes produced from large cores during initial stages of core reduction (Dragoo 1973). Many of these artifacts exhibit retouch on the side or end, and were likely utilized as scrapers. Cores are found in two forms at Wells Creek, polyhedral and tabular, and are found in abundance, with many appearing to have been used as tools for "scraping, woodworking and engraving" (Dragoo 1973; 39). It should be noted that Wells Creek Crater is considered a long-term habitation site and not a quarry as raw material in blocky or tabular form was brought to the site to be reduced into tools. Whether the lithic deposits represent a single or multiple episodes of occupation is unknown as the previous landform has been subjected to erosion. At Well's Creek, the blade and blade core industry is only dated through its association with fluted Clovis projectile points. However, a recent reanalysis of the Wells Creek lithic collections (Tune 2010) suggests that many blades at the site do not fit the description of Clovis blades as defined by Collins (1999a).

Williamson Site (44DW1)

The Williamson and Cactus Hill sites are located near the Nottoway River drainage on the coastal Plain of south-central Virginia. At Williamson, initially identified as a quarry and quarry-related base camp (McCary 1951), blades and polyhedral blade cores have been recovered through extensive surface collection, and more recently controlled excavations (Hill 2002). Such artifacts are primarily a product of locally available chert, with minor numbers produced of nonlocal varieties and quartzites. The blades from Williamson are small when compared to those recovered from Topper and Gault. On average, Williamson blades are less than 50mm in length (McAvoy 1992). Tools made on blades include end scrapers and gravers, and a number of blades show evidence of having been used unmodified. A number of core types have been recovered through uncontrolled surface collection, and range in morphology from bifacial-discoidal, angular-spheroid-amorphous, tabular-block, as well as polyhedral-conical (Hill 2002). Hill concludes that in core reduction at Williamson, the inhabitants utilized a variety of sizes and shapes. In addition, most cores found to be associated with the production of blades were exhausted. Finally, in addition to blades, Williamson has yielded an abundance of complete fluted points as well as other retouched tool forms, suggesting that site use was geared toward the production of tools for a diverse range of on-and off-site activities.

Cactus Hill Site (44SX202)

At Cactus Hill, blades, blade cores, and fluted projectile points have been recovered from cultural strata in at least one excavation area, suggesting a Paleoindian presence at the site. In addition, a number of "Clovis-like" unifacial tools including side and end scrapers have also been recovered from the site (McAvoy 1997:101). Most common, however, are fluted point fragments, side scrapers and utilized flakes. While blades have been recovered in small numbers from strata identified as Paleoindian, biface reduction flakes and bifacial cores are rare at Cactus Hill. The raw material of choice in blade production appears to be quartzite, though jasper, rhyolite and chalcedony are also present at the site in other tool forms (McAvoy 1997).

Big Pine Tree Site (38AL143)

The Big Pine Tree Site is a prehistoric multi-component quarry and quarry-related lithic processing site located in the Savannah River Valley of Allendale County South Carolina (Goodyear 1999). The site is located approximately 2km north of Topper. The presence of high quality chert, locally available as river cobbles from the bottom of Smith Lake Creek would have provided Paleoindians with excellent lithic resources (Goodyear 1999).

Archaeological investigations at Big Pine Tree have uncovered an abundance of buried artifacts within the alluvial terrace adjacent to the creek bank. Included within this material was found a number of fluted bifaces of probable Clovis origin. Big Pine Tree is significant archaeologically, having alluvially buried intact Clovis deposits, overlain by sediment containing artifacts spanning the entire cultural sequence from the region (Goodyear 1999). In addition to fluted bifaces, an abundance of blades, cores, and blade production debitage have also been recovered through a number of seasons of field excavations.

A preliminary examination of the blade assemblage at the Big Pine Tree found a high incidence of modified blades and tools made on blades at the site. Five examples are presented in Figure 57. From a sample of 474 blades, 39 of the complete blades exhibit some form of modification. This finding is in contrast to the blade assemblage at Topper, where only three percent of all identified blades exhibit evidence of modification.

At Big Pine Tree, a high percentage of the blade assemblage is comprised of examples that are small, less than 30mm in length. Of 315 complete blades, only 71 are greater than 50mm in length. Though modification is present on blades from nearly every size class, it appears that longer blades were chosen for modification in higher frequencies than were the shorter blades. However, given that the number of longer blades onsite is small when compared to the quantity of shorter blades, this pattern may indicate that some "macro" blades were carried off-site for use elsewhere. The discovery of small blades in Clovis contexts is intriguing in that blades of such size are generally not thought to be part of the Clovis lithic toolkit (Collins 1999a), and therefore, may represent a regional variation in strategies of blade production.

Formalized blade cores at Big Pine Tree come in two forms: (1) polyhedral with unidirectional blade removals struck from a single platform, or (2) multidirectional, with scars struck from two or more platforms. A total of 13 cores and core fragments from Clovis bearing strata at the site have been identified. Of particular interest is the discovery of cores that appear to have been used for the production of small blades (Figure 58). Five examples have been recovered from the site. These cores have two or more parallel blade removal scars that are 50cm or less in length, and exhibit preparation along one or more core platform surfaces. Blade core fragments from the site have two or more scars of previous blade removals from at least a single core face. At least three of these fragments appear to be core rejuvenation flakes. In addition to the excavated artifacts identified at Big Pine Tree, a number of blades and cores that exhibit similar technological and morphological attributes have been recovered out of context from the adjacent creek bed. These, as well as numerous other artifacts have been recovered here, deposited as a result of the sites western margin eroding into the creek. The overall pattern of blade technology and technological organization present at Big Pine Tree, including the high incidence of retouched and utilized blades, strongly suggests on site craft activities as an important site function.

A Comparison of Topper Blades to other Southeastern Clovis Sites

A comparison of the blade technology and technological organization at Topper with other Southeastern Clovis sites reveals a number of notable distinctions. First, only Topper, Big Pine Tree, Carson Conn Short, and Cactus Hill have been extensively excavated, while all other sites represent surface collections or limited test excavations. This observation is critical in that assemblages recovered from sites without reliable stratigraphic context can only be relatively dated from the diagnostic attributes present among their tool forms. An examination of the published literature shows that technologically, Topper blades are most similar to blades recovered from Carson Conn Short. For example, at both sites blades have been recovered that were struck uni-directionally from a number of core forms. Such blades are typically triangular to trapezoidal in cross section (Stanford et al. 2006). Moreover, wedge-

Figure 57. Modified blades and blade fragments recovered from the Big Pine Tree site (38AL143).

Figure 58. Small blade cores from the Big Pine Tree Site.

shaped cores are frequently “hoof- shaped” in cross section. Finally, like Topper, the lithic assemblage recovered from Carson Conn Short contains artifacts that result from the entire sequence of blade production. Of the other sites examined, only at Adams is the entire sequence of manufacture also present.

Raw Material Resources

The type(s) of raw material procured at a quarry likely affected the forms of cores that were able to be produced (Hill 2002). Differences in lithic raw material size, shape, and quality can relate to differences in the reductive approaches carried out at a site. For example, if raw material is not of adequate size, it may not have been possible to produce blades of a desired length. In this section, I provide a description of the available lithic raw materials that were utilized at Southeastern sites where blade assemblages have been reported.

In the Middle Savannah River Valley, lithic assemblages were primarily manufactured from locally available coastal plain (Allendale) chert, part of the Flint River and Barnwell formations that are exposed as nodular outcroppings along eroded hillsides. Tabular forms of chert have been observed in the vicinity, though it is not currently known how widely such forms are distributed throughout the quarry district. The cryptocrystalline outcrops of the area are unique to the Savannah River Valley of Allendale County, and provided Paleoindians with adequate resources from which to produce stone tools. At Topper and Big Pine Tree, such nodules from the hillside and river-bed would have been exploited for tool manufacture. However, certain material properties of these cherts may have presented Paleoindians of the area with challenges in blade manufacture. For example, while Allendale chert is considered a high quality cryptocrystalline material, it is not without material flaws. Furthermore, nodules or cobbles greater than 75mm in diameter are rare. At Topper, most recovered complete formalized blade cores are small in size (<75cm diameter). These cores frequently exhibit evidence of errors in the form of hinge and step fractures on the exterior face. While core size relates to a combination of factors including degree of reduction, the discovery of so few blades that are greater than 100mm in length (12) at Topper would seem to suggest that raw material size was one contributing factor in blade core morphology in addition to technological approach.

A primary source of lithic raw material in Tennessee was the Ft. Payne cherts, part of the Dover formation. They were utilized by Clovis groups that occupied the Carson Conn Short, Sinclair and Wells Creek Crater Sites. Varieties of Ft. Payne cherts include Waverly, Buffalo River, and Dover. Unlike Allendale chert, which is commonly available as exposed nodules, the Ft. Payne formation contains both “nodular as well as bedded chert types of varying consistencies” (Parish 2009:31). The internal structure of Ft. Payne chert is described as “very uniform, composed of cryptocrystalline silica with small amounts of chalcedonic silica and irregularly shaped spherulites” (Parish 2009: 32; Marcher 1962b). At Adams and The Little River Clovis Complex in Kentucky, Hopkinsville chert is available in tabular as well as nodular form. The availability of raw material resources in multiple forms (tabular as well as nodular chert) was amenable to strategies of blade reduction for Clovis groups of the region. However, Sanders (1988) notes that nodular chert was the material of choice at Adams, most frequently utilized for blade core reduction. At Cactus Hill, quartzite cobbles from the nearby riverbed formed a significant source of raw material (McAvoy

1997). Quartzite is less isotropic, less homogenous, and retains less plasticity than chert. As such, the ability of Clovis knappers to produce blades of a specified form was dependent not only upon the particular techniques employed in the manufacture process, but also in the quality and morphology of available raw material resources.

An examination of the published literature on blade morphology found that Topper blades are on average shorter than proposed Clovis blades reported at Adams and Carson-Conn Short (Sanders 1990). However, Topper blades are much longer than blades identified at Williamson or Cactus Hill. At Topper, blade manufacture of a specified length may not have always been feasible, as raw material may not have been available in suitable sizes and or shapes. Moreover, variation in the internal raw material properties of available forms across the Southeast likely influenced the morphological discrepancies present in the observed blade assemblages from these regions. Topper is unique in some aspects of blade manufacture and technological organization. One of the most interesting discoveries is the rarity of retouched or modified blades and tools made on blades at Topper, when compared with the frequency of such tools from other assemblages. Modified blades have been found at Adams, Williamson, Carson Conn Short, and Nuckolls, and occasionally in abundant numbers. At Adams, nearly all artifacts identified as blades exhibit modification. This includes retouch along one or both ends, side (both unilateral and bilateral) retouch, as well as the production of gravers on blades (Sanders 1990). At Nuckolls, 72% of the complete blades exhibit some form of modification, with blade use activities encompassing a variety of tasks at habitation and quarry locales (Ellerbusch 2004). Of the sites included in this discussion, only at Sinclair are blades and other tools found to be a rare occurrence. The low percentage of modified and retouched blades at Topper implies the use of an alternative technological organization by the Clovis inhabitants of the area. While the presence of choppers, denticulates and expedient tools such as utilized flakes suggests that some lithic manufacture at Topper was carried out for onsite use, blades, on the other hand, do not appear to have been manufactured and modified onsite for such purposes. This conclusion, however, does not suggest that the failed and/or rejected blades left at the manufacturing locales were not valued as tools.

Technological Organization

In terms of lithic technological organization, we may infer that Topper is most comparable to the Sinclair Site, while sharing the least similarity to Nuckolls and Wells Creek Crater. For example, from a functional stand-point, Topper and Sinclair appear to have been quarry and short- term occupation sites where nodules of chert were procured and initially reduced into early stage bifaces and blades. Moreover, neither site appears to have an abundance of modified blades or blade tools, suggesting that such tools, if produced onsite, were subsequently removed off-site, or have yet to be discovered.

Unlike Topper and Sinclair, the Nuckolls and Wells Creek Crater sites are not quarry-related. Rather these sites represent lithic manufacture and habitation sites where raw material, once reduced to manageable forms was brought onsite from afield, to be completed into finished tools at the site. Furthermore, the presence of numerous tool forms at Wells Creek Crater, including core tools with working edges that have been worn, supports the notion that a number of activities were taking place onsite apart from tool manufacture. At Nuckolls, unlike at Topper, blades were manufactured from a variety of locally available high quality cherts, as opposed to a single material type. Thus further supporting the notion that lithic material, in unfinished form, was transported to the site from afield Finally, the lack of onsite cores implies that initial blade production was carried out at other locales prior to being transported to the site where they were ultimately discovered.

Carson Conn Short and Big Pine Tree are quarry-related lithic manufacture base-camps. These sites exhibit evidence of the extraction and reduction of onsite or locally available raw material into finished or nearly completed blades. The presence of modified blades among other unifacial tools onsite suggests that activities apart from quarry-related were also taking place. At Big Pine Tree for example, the higher frequency of modified blades would seem to imply that the Clovis inhabitants gave a greater emphasis to the use of blades onsite than at Topper. This finding is further supported by the greater density of artifacts per square meter of excavation at the site. Moreover, onsite habitation is suggested due to the presence of additional unifacial tools such as end and side scrapers produced on blades, an artifact type lacking at Topper. A number of these scrapers are hafted, and exhibit polish on their scraper bits, suggesting prolonged use.

The patterns of lithic technological organization evident from the blade assemblages discussed above suggest that Paleoindian hunter gatherers of the region situated their settlement systems according site function. These include Quarry extraction sites such as Topper and Sinclair. The positioning of these sites is predicated on the placement of resource rich environments for the procurement of stone for tool production. Other site types are manufacture and habitation sites and include Nuckolls and Wells Creek, and finally quarry-related lithic manufacture base-camps like Big Pine Tree and Carson Conn Short. It is of no surprise that some of these site types may be found in relative proximity to another such as Big Pine Tree is to Topper. Future studies should seek evidence of nearby sites that may have played a supporting role in the overall settlement subsistence system of each region.

Blade Technology and Technological Organization in the Greater Savannah River Valley

An analysis of a sample of Clovis blades recovered from the Topper Site found that modified blades are rare at Topper, occurring only on 3% of the blades examined. A subsequent examination of the published literature found that the incidence of blade modification occurs in much greater frequencies at other sites throughout the Southeast. In an effort to interpret what the relative rarity of blade modification at Topper represents, as well as the pattern(s) of technological organization in the region, three models were proposed. In sum:1. Blades were manufactured for use unmodified onsite. 2. Blades produced onsite, were subsequently transported for off-site subsistence purposes. 3. Pre-fashioned cores, and not blades were the object of transport. In order to explore these models, a sample of fifteen blades recovered from locations offsite, and at distances of up to 100 miles from Topper were examined (Appendix V). These blades were recovered afield, as surface finds by various collectors. All examples are a product of Allendale Coastal Plain chert. The geographical distribution of seven of these blades is presented in Figure 59. If blades were produced at quarries such as Topper, and

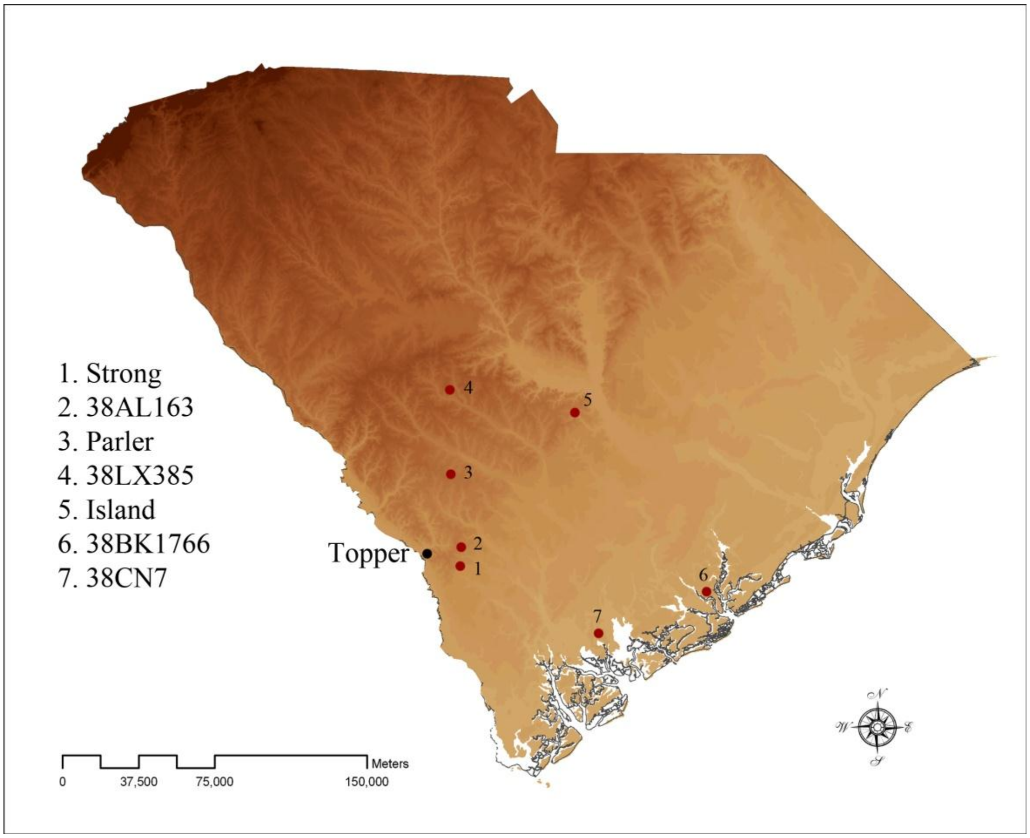

Figure 59. The locations of modified blades made of Coastal Plain chert from South Carolina.

subsequently removed for uses afield, we should expect to find evidence of maintenance in the form of modification on the blades recovered from the surrounding region. In contrast, if blades were not removed some distance from quarries for subsistence use, I would expect little difference in the percentage of blade modification across space. Therefore, the sample of 15 blades was examined for evidence of modification. Additional technological and morphological attributes were recorded for comparative purposes, and include: scar count and directionality, cross section, platform angle, bulb characteristics, maximum blade length and width, platform width and thickness, and index of curvature.

The results of this analysis found that all 15 blades exhibit evidence of either lateral retouch, or some other form of modification. Of these blades, nine are complete, five are proximal fragments, and a single fragment is a medial section. Five of the modified blades are illustrated in Figure 60. The post-detachment modification usually consists of bilateral unifacial retouch. Four blades exhibit such retouch along both margins and an end, while two additional blades have retouch only along the margins. The lateral edge angles for the modified blades are acute, ranging from 30-45 degrees respectively. At least one blade has been modified to create a multi- functional tool (Figure 61). One may expect lithic tools such as blades to exhibit greater attributes of

Figure 60. Modified blades from locations at distance from Topper.

utility and maintenance the further one travels from raw material sources such as quarries. The blades recovered from off-site contexts were subsequently compared to the Topper assemblage. A T-test was conducted in order to determine if there exists any statistical difference in the morphological attributes of the modified blade assemblages (Table 50). The results of this test demonstrate that there is no statistically significant difference in any attribute, with the exception of platform thickness. Blades recovered from the outlying region, and at distances from Topper, are technologically comparable to Clovis in origin. Apart from the presence of modification, technological attributes consistently found on these blades include multiple parallel uni-directional scars of previous removals on the exterior surface, cross sections that are triangular to trapezoidal in form, and platform angles that are greater than 60 degrees. Moreover, all but a single example have bulbs of force that are diffuse. Likewise, blade margins are predominantly parallel. Only one blade has a slightly curved profile. In sum, the technological attributes identified for blades off-site, apart from the modification, are generally consistent with examples recovered from Topper. Morphologically, complete modified blades recovered from off-site contexts are longer and have greater curvature than the unmodified blades recovered at Topper (Appendix V, Table 50). However, there is no statistical difference in blade length or curvature when the Topper modified blades (16) are compared to the modified blades recovered off-site. Based on these findings, it would appear that the same or similar manufacture techniques were employed in the production of blades from these two samples. It is of note that a detached blade is best suited for use in unmodified form. Blade modification in the form of retouch is employed as a means of resharpening or rejuvenating the blade edge when margins become dull through use. Such measures allow longer use-life for blades and blade tools. While the blades from off-site contexts have some elements consistent with a reliable design strategy (i.e. slightly more

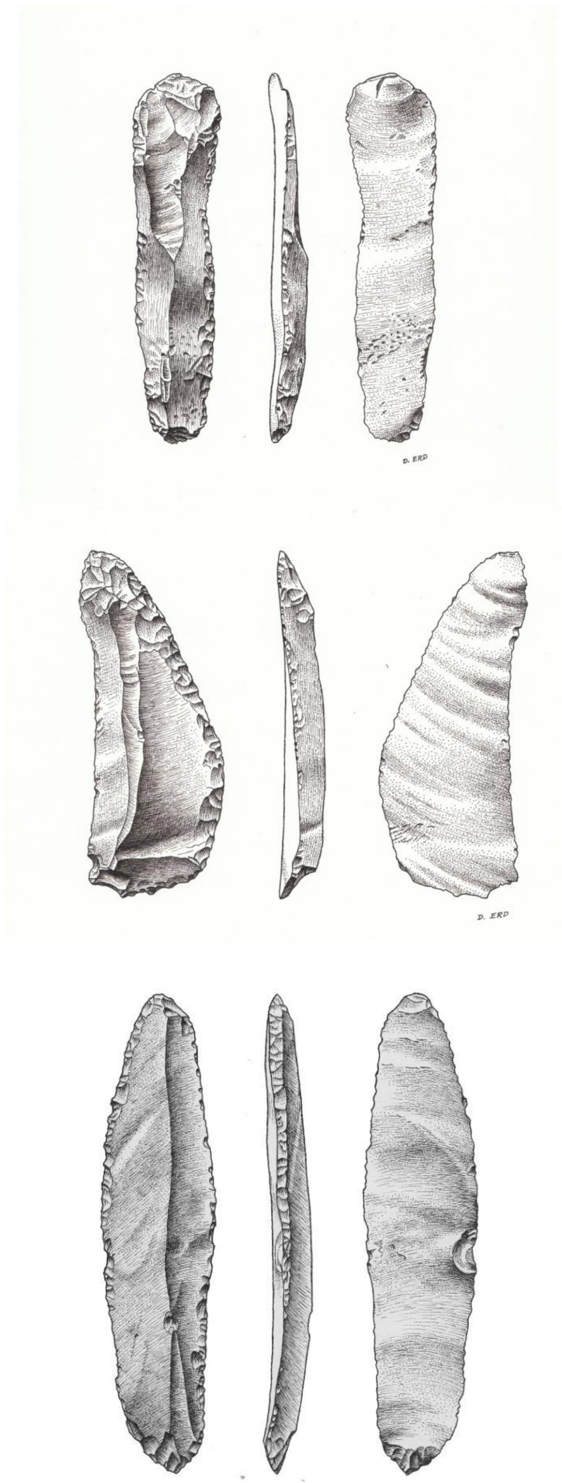

Figure 61. Modified Blades. (Image courtesy of Darby Erd).

pronounced curvature, increased lengths for maximum cutting edge), the presence of multiple worked margins and evidence for rejuvenation are consistent with maintainable designs. Maintainable design strategies are more suitable where there exists a continuous need for specific too forms yet raw material for tool manufacture is increasingly dispersed and unpredictable.

If we assume that (1) artifacts that fit the definition of a blade, and are produced from Allendale Coastal Plain chert are present at Topper and (2), that modified artifacts that also fit the definition of a blade, and produced from Allendale Coastal Plain chert are present in areas at distance from source; we can then predict that the modified artifacts recovered at distances from source *may* have been produced at Topper, one of thirteen known prehistoric chert quarries that are geographically restricted to the Savannah River Valley of Allendale County, SC. However, future sourcing studies are in need to corroborate the results of this technological analysis.

The low percentage (3% of the sample) of modified blades found at Topper, combined with the discovery of such artifacts of probable Clovis origin at distances off-site, suggests the possibility that blades best suited for use as tools *may* have been transported from the quarry for use elsewhere. Such results reflect a curated strategy of lithic technological organization. Moreover, the technological attributes (wide striking platforms, diffuse bulbs of force) often found for modified blades recovered afield, are considered here to reflect specific manufacture techniques, chosen in response to locally available coastal plain chert. The variation reported among blade attributes from other documented Clovis sites (e.g. small striking platforms and high, excessive indexes of curvature) in the Mid-South and Southern Plains, likely reflects manufacture

Table 50. Results of a T-test comparing the attributes of modified blades from Topper to blades recovered from off-site contexts.

	Topper (n =7)		Off site Contexts			
	Mean	SD.	Mean	SD.	T-statistic	Probability
Length	97.40	39.807	97.9	18.0925	0.0302	0.9764
Width	38.40	14.524	30.7	14.524	1.1887	0.2576
Curvature	6.21	4.910	4.44	3.180	0.7039	0.4976
Platform Width	10.97	3.493	9.64	4.627	0.6051	0.5564
Platform Thickness	9.50	3.750	3.74	1.6215	3.9571	0.00016

$\alpha = .05$; Two tailed test of independence.

techniques chosen in response to alternative raw material forms (Collins 1999a). In addition to the blades, cores are also present at Topper. These artifacts have been recovered in various stages of reduction, sometimes exhausted, and are frequently found in association with blades and blade production debitage. However, the majority of Topper cores are informal varieties. A total of only 22 artifacts from a sample of 87 were identified as formalized blade cores. Cylindrical, conical and wedge shaped cores are rare at Topper, and many are fragments. These cores often have few parallel scars of previous removals taken from one or more surfaces. The low abundance of formalized blade cores found at Topper may reflect a scarcity in homogenous high quality cherts of large enough sizes for the removal of numerous large blades (Goodyear 2006). As such, blades that are of acceptable dimensions, or that fit the intended objective, would have been a valued commodity to Clovis groups in the region.

The findings of this analysis are in support of the second model as described above: that is, Topper blade cores were reduced onsite for the production of blades, and that blades best desired were subsequently transported offsite. There are a number of results that are in support of this model. First, there are few modified blades at the quarry. Second, blades discovered from off-site contexts are larger, and exhibit evidence of modification. The unmodified blades recovered at the quarry are shorter and straighter than the off-site modified blades. Blade modification is a form of maintenance, or for specific use, and would have been conducted as a means to extend the use-life of a tool in areas of less abundant raw material. The modified blades examined from offsite contexts fit this description. They have long term utility, capable of being fashioned or reworked into a number of tool forms as is evident from the middle example depicted in figure 60. Accordingly, model 2 maximizes the number of tools able to be transported while minimizing the transport cost of raw material (Kelly and Todd 1988).

Finally, there is little evidence of blade cores or blade production debitage associated with the isolated blade discoveries from the surrounding region. If blades were produced from transported cores, one would expect to find evidence of the discarded cores and or blade production debitage from off-site contexts. Such cores have yet to be found, though future excavations at such locales may prove otherwise. If the blades recovered offsite were a product of transported cores, such cores were likely completely reduced prior to discard, leaving behind little evidence for their existence, save the finished blade product.

The conclusions herein appear to mirror those found for the fluted points recovered at Topper. Only four Clovis points have been recovered from 596 square meters of excavation at the site. Clovis preforms are found in various stages of production onsite; however, most of the examples recovered are segments, predominantly distal bases, and complete fluted points at the site are extremely rare (Smallwood 2010). These facts appear to support the conclusion that the majority of completed points, like blades, were transported offsite, and that those found at the site consist of discards, broken segments, or reworked tips (Smallwood 2010).

At least one result of this analysis is not in support of model two. If blades were produced at Topper, one should expect equally abundant evidence of all stages of blade manufacture at the site. However, this is not the case. While there are numerous interior blades, there are fewer primary blades and secondary blades. A number of factors could explain the relative absence of primary blades at the site. First, it is possible that initial blade core production results in detachments that are flakes as opposed to technological blades. Or, it may be that technological blades are not produced until after the core has been initially shaped. This manufacture trajectory in some cases may result in the production of crested blades, a blade type found in more abundance at the site.

The pattern of Clovis blade production, transport and discard found at Topper and the surrounding Savannah River Valley suggests that (1) onsite blade manufacture was geared toward tool production for use away from the quarry, and (2) that technological blades present onsite represent discards of the manufacture process. The discovery of isolated multifunctional blade tools from the outlying region alludes to the significance of quarries as sources of raw material for purposes of tool replenishment. As the chert sources of the region are geographically restricted to the Savannah River Valley, such findings imply that logistical, curated approaches to tool manufacture were carried out by prehistoric peoples of the region. Studies that take into account the relationship(s) between quarry assemblages and isolated stone tool discoveries can be used to test models of prehistoric life-ways. Future studies should examine the potential for variation in other tool forms, across different regions, and also in locales of varying raw material availability. Such studies will help to address site function, and regional patterns in assemblage variation.

Chapter VIII

STUDY SUMMARY

The purpose of this study was to document technological approaches to Clovis blade production at the Topper site. In order to do so, it was first necessary to determine if the artifacts previously identified as blades at the site are the product of technological blade manufacture, or if such artifacts were produced by other reductive approaches such as biface or flake core production. To differentiate blades from blade-like flakes, an attribute value analysis was employed. This analysis examined six attributes considered to be characteristic of Clovis blades. Artifacts having higher total attribute values are those considered to be more diagnostic of Clovis blade manufacture. More importantly, this method of analysis enables results to be quantified, allowing comparisons with other blade assemblages.

The results of the attribute value analysis show that artifacts can be identified as blades at Topper, and that these are probably the product of technological blade manufacture, as they meet the definition of a blade core technology. Such blades have at least three of the following: parallel lateral margins, at least two parallel uni-directional scars of previous blade detachments on the exterior surface, have platform angles of 60 degrees or greater, and cross sections that are triangular or trapezoidal in form. Moreover, the bulbs of force on blades are diffuse/expanded as opposed to salient/prominent, and distal terminations are thicker than blade proximal ends. In addition to blades, artifacts identified as blade-like flakes are also present at Topper. These artifacts have one or two characteristic attributes of blades, but fail to meet the required definition of a technological blade. Blade-like flakes are considered here to represent other approaches of lithic manufacture such as biface or core flake production.

Once it was established that a blade core technology was present at Topper, a subsequent analysis was undertaken in order to identify sequences in the blade manufacture process. This analysis involved examining each artifact for the presence or absence of cortex and the number of scars on the exterior surface of each detachment. It was found that the entire sequence of blade production is present at Topper. However, interior blades that lack exterior surface cortex, and exhibit two or more removal scars are most abundant. Additional analysis was designed to determine the reduction techniques employed in blade production at Topper. This analysis used attributes of platform size and bulbar definition to distinguish hard, soft, direct and indirect applications of force. Results found that hard hammer direct percussion was likely employed for initial and early stages of core reduction, with soft hammer direct percussion employed during secondary and late stages of reduction.

This study identified at least three types of formalized blade cores that have been recovered from Topper, and from which blades were detached. Cylindrical and conical cores are infrequent at Topper. The examples that have been recovered all appear to be exhausted or nearly exhausted. Of the forms identified, wedge shaped cores occur most often at the site. An examination of the wedge cores from Topper found most to differ when compared to descriptions of such cores from other Southeastern quarry sites. At Topper, wedge cores are bi-directional, or multi-directional in form, with scars of blade detachments emanating from two or more platforms. Blade production began with the removal of blades from a single face. When blades of the desired form were no longer possible, the core was rotated and blades were struck from opposing or perpendicular platforms. This reduction method resulted in blades whose morphology appears "hoof shaped".

In most cases, blade production at Topper appears to be largely influenced by properties of material quality, size, and shape. Raw material available at the site comes in the form of rounded nodules, often without preexisting platforms from which blades may be struck. As a consequence, striking platforms were created through the removal of rounded natural tops that enabled suitable conditions for subsequent blade removals.

Raw material package sizes large enough to produce blades of a specified length may not have been present in abundance at Topper. This assumption is based on blade morphology at Topper, specifically as it relates to blade length. Blades at Topper are on average much shorter than blades documented at a number of other sites throughout the region. The results of a T-test validate this assumption. An examination of the blade production debitage at Topper found most to consist of by-products of the initial reduction sequence. Core face rejuvenation flakes are present in limited numbers, and it appears that core tablet flakes are rare or absent at Topper. This finding further supports the view that Clovis knappers at Topper gave a greater emphasis to core rotation when errors occurred, rather than the removal of additional raw material in the preparation and detachment of core tablet flakes.

The blade attributes found to be most common at Topper were statistically compared to other known Clovis blade assemblages. At Topper, blades were found to generally have wide platform remnants, diffuse bulbs of force, and longitudinal profiles that are straight. However, Collins finds Clovis blades to exhibit small platform remnants, and have curved longitudinal profiles. Clovis blades at Topper are statistically different in terms of blade length, platform size, and curvature than other known Clovis blade assemblages. Variation in platform size can be a result of different techniques employed in blade detachment (i.e. direct versus indirect percussion). Blade curvature is a result of a number of factors including but not limited to (1) how the core is held in place, (2) raw material type, morphology and quality, (3) force application, and (4) point of reduction stage at which the blade was detached.

Though the findings of this study demonstrate that Clovis blades at Topper differ from the traditional definition of a Clovis blade, it is important to note that Topper is a quarry related reduction site where blades are found in various stages of production. As such, the attributes present on blades from the site may have differed from those found on blades if taken offsite, and used afield. As a test for such variation, a sample of blades recovered from off-site contexts was examined. This analysis was conducted as a test for variation in blade attributes, and to provide insight into technological organization, design strategies, and patterns of mobility. The results of this study have found that technological blades recovered from isolated offsite contexts are often modified, have multiple functioning tool edges, and share many attributes characteristic of the traditional definition of a blade. Such characteristics support a design strategy that incorporates some elements of reliability, though is geared toward a maintainable toolkit. Most blades recovered at Topper are unmodified, and are shorter than off-site examples, and may represent rejects or discards of the manufacture process.

An examination of the published literature found there to exist a number of assemblages at sites throughout the Southeast having blades recovered in association with fluted projectile points. The Topper blade assemblage was compared to these sites in an effort to identify the presence or absence of any variation in approaches of formalized blade production. Based on the results of this comparison, there does appear to be some regional variation in blade technology, though a number of similarities do exist. The most striking finding was the rare occurrence of modified blades at Topper while numerous artifacts of such type are present at similar sites throughout the region. The low percentage of modified blades, combined with the similarly low percentage of fluted points at Topper provide evidence that such tools were being manufactured for uses away from the quarry.

This study explored three possible models of technological organization at Topper. In the first, blades were manufactured at Topper to be used unmodified onsite. The second model examined whether the Topper blade assemblage was largely composed of unsuccessful detachments or discards of the manufacture process. In this model, blades would have been manufactured onsite, with suitable products ultimately transported for use elsewhere. A third model suggests that preformed cores were the focus of reduction, whereby manageable forms were transported elsewhere for blade production to occur as needed. The second and third model support an emphasis toward curated lithic behavior as it pertains to technological organization. In contrast, model I supports an expedient design strategy.

An examination of the formalized blade cores shows that many were discarded at or during late stages of reduction, if not already exhausted. Such cores would not have been suitable for subsequent, future offsite blade production. Based on the results of this analysis, formalized blade core reduction at Topper was found to be geared toward the production of blades as opposed to preformed cores for transport and use elsewhere. The pattern of blade production and discard evident at Topper suggests that such methods of lithic tool manufacture at the site were geared toward the production of blades for off-site subsistence use. This finding corresponds with model two as described above.

Directions for Future Research

There are a number of issues where future research may enable a broader understanding of Clovis blade technology at the Topper site. One area is use-wear studies. Such an analysis was beyond the scope of the current study, though it may be beneficial in forming additional interpretations regarding the purpose and function of blades and blade manufacture at the site. For example, a lack of retouch or modification found on blades at Topper does not necessarily preclude a lack of blade use onsite. Blades detached at the quarry may have been used onsite for a number of activities though left unmodified. In such instances, an analysis of polish or residue left along blade margins, if present, can aid in demonstrating functions such artifacts served, and to specific activities that may have been carried out onsite.

Like use-wear studies, spatial analysis is an area of research that may prove useful in providing a broader understanding of blade technology and organization at Topper. For example, such studies not only can inform on specific locations and intensity of lithic reduction, but can also lead to inferences concerning patterns of intra site variation in artifact class, and ultimately site function.

Specifically, a spatial analysis that examines the relationship(s) between areas of blade production, and other classes of tool forms may demonstrate whether specific areas were once used for alternative approaches to lithic tool production.

Finally, an in depth technological examination of the Topper tool assemblage, including unifaces and side/end scrapers is necessary to provide a broader understanding of site use. For example, did Topper, as a quarry-related lithic workshop site serve only as a locale for raw material acquisition and tool production, or did it also serve as a craft and short-term habitation site where a number of tool forms may have been used? Moreover, because the results of this analysis derive from the examination of a sample of artifacts, and were not recovered from every location of excavation onsite, it is possible that some artifacts that meet the technological requirements of blades were missed. As such, further analysis is warranted. This entails a thorough examination of the lithic collections housed at the South Carolina Institute of Archaeology and Anthropology. However, such analyses with subsequent comparisons to nearby contemporaneous lithic assemblages may further our understanding of Clovis adaptive systems in the greater region.

REFERENCES CITED

Anderson, David G.,

1990 The Paleoindian Colonization of Eastern North America: A View from the Southeastern United States. In *Early Paleoindian Economies of Eastern North America*, edited by Kenneth Tankersley and Barry Isaac, pp. 163–216. Research in Economic Anthropology Supplement 5.

1996 Models of Paleoindian and Early Archaic Settlement in the Southeastern United States. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 29–57. University of Alabama Press, Tuscaloosa.

2005 Pleistocene human occupation of the southeastern United States: Research Directions for the Early 21st Century. In *Paleoamerican Origins: Beyond Clovis*, edited by Bradley T. Lepper, Robson Bonnichsen, Dennis Stanford, and Michael R. Waters, pp. 29–42. College Station: Texas A&M University Press.

Anderson, David G., and Michael K. Faught

2000 Paleoindian artefact distributions: evidence and implications. *Antiquity* 74:507–513.

Anderson, David G., and Kenneth E. Sassaman, editors

1996a *The Paleoindian and Early Archaic Southeast*. Tuscaloosa: University of Alabama Press.

Anderson, David G., and Kenneth E. Sassaman

1996b Modeling Paleoindian and Early Archaic Settlement in the Southeast: A Historical Perspective. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 16–28. University of Alabama Press, Tuscaloosa.

Anderson, David G., Lisa D. O'Steen, and Kenneth E. Sassaman

1996 Environmental and chronological considerations. *In The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 3–15.Tuscaloosa: University of Alabama Press.

Anderson, David G., D. Shane Miller, Stephen J. Yerka, J. Christopher Gillam, Erik N. Johanson, Derek T. Anderson, Albert C. Goodyear, and Ashley M. Smallwood.

2010 PIDBA (Paleoindian Database of the Americas) 2010: Current Status and Findings. *Archaeology of Eastern North America* 38:63–90.

Andrefsky, William J

1986 Numerical types and inspectional types: evaluating shape characterization procedures. *North American Archaeologist* 7:95–112.

1998 *Lithics: Macroscopic Approaches to Analysis*. Cambridge: Cambridge University Press.

2005 *Lithics: Macroscopic Approaches to Analysis*. 2nd edition. Cambridge University Press.

Bamforth, Douglas. B.
1986 Technological Efficiency and Tool Curation. *American Antiquity* 51:38–50.

2002 High-tech foragers? Folsom and later Paleoindian technology on the Great Plains. *Journal of World Prehistory* 16:55–98.

Bamforth, Douglas B. and Peter Bleed
1997 Technology, flaked stone technology, and risk. In *Rediscovering Darwin: Evolutionary Theory in Archaeology*, edited by G.A. Clark, pp. 109-140. Archaeological Papers of the American Anthropological Association, No.7. American Anthropological Association, Washington, D.C.

Baumler, Mark F.
1995 Principles and properties of lithic core reduction: implications for Levallois technology. In *The Definition and Interpretation of Levallois Technology*, edited by H. L. Dibble and O. Bar-Yosef, pp. 11–23. Prehistory Press.

Binford, Lewis R.
1977 Forty-seven trips. In Stone Tools as Cultural markers, edited by R. S. V. Wright, pp. 24–36. Australian Institute of Aboriginal Studies, Canberra.

Bleed, Peter
1986 The optimal design of hunting weapons: maintainability or reliability. *American Antiquity* 51: 737–747.

Boldurian Anthony T.
1991 Folsom mobility and organization of lithic technology: a view from Blackwater Draw, New Mexico *Plains Anthropologist* 36:281–295.

Boldurian Anthony T., and E. Hoffman
2009 Clovis blade manufacture: analytical procedure to infer "technique." *North American Archaeologist* 30(2):167-194.

Boldurian, Anthony T., and J. L. Cotter
1999 *Clovis Revisited: New Perspectives on Paleoindian Adaptations from Blackwater Draw, New Mexico*. University of Pennsylvania Museum of Archaeology and Anthropology, Monograph 103, Philadelphia.

Bonnichsen, Robson, and Karen L. Turnmire, editors
1991 *Clovis: Origins and Adaptations*. Center for the Study of the First Americans, Corvallis, Oregon.

Bordes, Francois.
1961 Mousterian cultures in France. *Science* 134(3482):803–810.

Bordes, Francois, and Crabtree, Don
1969 The Corbiac blade technique and other experiments. *Tebiwa* 12:1–21.

Bradbury, Andrew P., and Philip J. Carr
1995 Flake typologies and alternative approaches: an experimental assessment. *Lithic Technology* 20:100–115.

1999 Examining stage and continuum models of flake debris analysis: an experimental approach. *Journal of Archaeological Science* 26:105–116.

Bradley, Bruce A., and Dennis Stanford
2000 The North Atlantic Ice-Edge corridor: a possible Palaeolithic route to the New World. *World Archaeology* 36(4):459–478.

Broster, John B., and Mark R. Norton
1996 Recent Paleoindian Research in Tennessee. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 288–297. Tuscaloosa: University of Alabama Press.

2009 The Sinclair Site (40Wy111): A Clovis quarry along the Buffalo River in Wayne County, Tennessee. *Current Research in the Pleistocene* 26:35–36.

Callahan, Erret
1979 The basics of biface knapping in the eastern fluted point tradition. *Archaeology of Eastern North America* 7:1–180.

Carr, Philip J. and Andrew P. Bradbury
2001 Flake debris analysis, levels of production, and the organization of technology. In *Lithic Debitage Analysis: Studies in Context, Form, and Meaning,* edited by W. Andrefsky, pp. 126–146. University of Utah Press, Salt Lake City.

2011 Learning From lithics : a perspective on the foundation and future of the organization of technology. In Special Issue: Reduction Sequence, Chaîne Opératoire, and Other Methods: The Epistemologies of Different Approaches to Lithic Analysis, edited by Gilbert B. Tostevin. *PaleoAnthropology* 2011:305–319.

Chandler, Jim
2006 Clovis at Topper. *Mammoth Trumpet* 21(4):16–23.

Charles, Tommy
1981 Dwindling Resources: An Overture to the Future of South Carolina's Archaeological Resources. *Institute of Archaeology and Anthropology*, *The Notebook* 13:1–85. University of South Carolina, Columbia.

Clarkson, Chris
2007 *Lithics in the Land of the Lightning Brothers: The Archaeology of Wardaman Country, Northern Territory.* Terra Australis 25. Canberra: ANU E Press.

Collins, Michael
1975 Lithic technology as a means of processual inference. In: *Lithic Technology: Making and Using Stone Tools,* edited by Earl Swanson, pp.15–34. Mouton Publishers, The Hague.

1999a *Clovis Blade Technology*. Texas Archaeology and Ethnohistory Series. The University of Texas Press, Austin.

1999b Clovis and Folsom lithic technology on and near the southern Plains: similar ends, different means. In *Folsom Lithic Technology: Explorations in Structure and Variation*, edited by D. S. Amick, pp. 12–38. International Monographs in Prehistory, Ann Arbor, Michigan.

2007 Discerning Clovis subsistence from stone artifacts and site distributions on the southern Plains periphery. In*: Foragers of the Terminal Pleistocene in North America*, edited by Renee B. Walker and Boyce N. Driskell, pp. 59–87. University of Nebraska Press, Lincoln.

Collins, Michael. B., and J. C. Lohse
2004 The nature of Clovis blades and blade cores. In *Entering America: Northeast Asia and Beringia Before the Last Glacial Maximum*, edited by D. Madsen, pp. 159–183. University of Utah Press, Salt Lake City, Utah.

Collins, Michael B., Dale B. Hudler, and Stephen L. Black
2003 *Pavo Real (41BX52): A Paleoindian and Archaic camp and workshop on the Balcones Escarpment, South-Central Texas*. Texas Archeological Research Laboratory, The University of Texas at Austin. Austin, Texas.

Condon, Peter C.
2005 *A technological analysis of early Paleoindian lithic assemblages: The 1963–1964 spring conduit excavation, Blackwater Locality No. 1*. Unpublished Master's Thesis. Department of Anthropology. Eastern New Mexico University.

Crabtree, Don E.
1966 A stoneworker's approach to analyzing and replicating the Lindenmeier Folsom. *Tebiwa* 9(1):3–39.

1967 Notes on experiments in flintknapping: 4- tools used for making flaked stone artifacts. *Tebiwa* 10(1):60–73.

1968 Mesoamerican polyhedral cores and prismatic blades. American Antiquity 33:446–478.

1970 Flaking Stone with Wooden Implements. *Science* 169:146–153.

1972 *An Introduction to Flintknapping.* Occasional Papers of the Idaho State University Museum, Number 28, Pocatello, Idaho.

1973 The obtuse angle as a functional edge. *Tebiwa* 16(1):46–53.

Daniel, I. Randolph, Jr., and Michael Wisenbaker
1987 *Harney Flats: A Florida Paleoindian Site*. New York: Baywood Press.

Deter-Wolf, Aaron, Jesse W. Tune, and John B. Broster
2011 Excavations and dating of late Pleistocene and Paleoindian deposits at the Coats-Hines site, Williamson County, Tennessee. *Tennessee Archaeologist* 5:142–156.

Dibble, Harold L., U. A. Schurmans, R. P. Iovita, and M. V. McLaughlin
2005 The measurement and interpretation of cortex in lithic assemblages. *American Antiquity* 70:545–560.

Dickens, William
2005 *Biface Reduction and Blade Manufacture at The Gault Site (41BL323): A Clovis Occupation in in Bell County, Texas*. Unpublished Ph.D. Dissertation, Department of Anthropology, Texas A&M University.

Dillehay, Tom D.
1989 *Monte Verde: A Late Pleistocene Settlement in Chile*, Vol. I. Smithsonian Institution Press, Washington, D.C.

1997 *Monte Verde: A late Pleistocene settlement in Chile, Vol. II: The Archaeological Context and Interpretation*. Washington, DC: Smithsonian Institution Press.

Dixon, E.J.
1999 *Boats, Bones, and Bison: Archaeology and the First Colonization of Western North America*. University of New Mexico Press, Albuquerque.

Dragoo, Don W
1973 Wells Creek: An Early Man Site in Stewart County, Tennessee. *Archaeology of Eastern North America* 1:1–56.

Ellerbusch, Elijah C.
2004 Paleoamerican Prismatic Blade Economy from the Nuckolls Site (40Hs60), Lower Tennessee River Valley, Tennessee. *Current Research in the Pleistocene* 21:35–38.

Ferring, C. Reid
2001 *The Archaeology and Paleoecology of the Aubrey Clovis Site (41DN479) Denton County, Texas*. Center for Environmental Archaeology, Department of Geography, University of North Texas, Denton.

Fiedel, Stuart

1992 *Prehistory of the Americas*. Second Edition. Cambridge: Cambridge University Press.

2000 The peopling of the new world: present evidence, new theories, and future directions. *Journal of Archaeological Research* 8: 39–103.

Figgins, J.D.

1927 The antiquity of man in America. *Natural History* 27: 229–239.

Fladmark, K.

1979 Routes: alternate migration corridors for early man in North America. *American Antiquity* 44:55–69.

Freeman, Andrea K. L., Edward E. Smith Jr., and Kenneth B. Tankersley

1996 A stone's throw from Kimmswick: Clovis period research in Kentucky. In *The Paleoindian and Early Archaic Southeast*, edited by David G. Anderson and Kenneth E. Sassaman, pp. 385–403. The University of Alabama Press, Tuscaloosa, Alabama.

Gardener, William M.

1974 T*he Flint Run Paleoindian Complex: A Preliminary Report 1971 through 1973 Seasons*. Occasional Paper No. 1. Archaeology Laboratory, Catholic University of America. Washington, D.C.

1977 Flint Run Paleoindian complex and its implications for Eastern North American Prehistory. *Annals of the New York Academy of Sciences* 288:251–263.

1983 Stop me if you've heard this one before: the Flint Run Paleoindian complex revisited. *Archaeology of Eastern North America* 11:49–59.

1989 An examination of cultural change in the Late Pleistocene and Early Holocene (circa 9200 to 6800 B.C.). In *Paleoindian Research in Virginia: A Synthesis*, edited by J. Mark Wittkofski and Theodore R. Reinhart, pp. 5–51. Special Publication 19. Richmond: Archeological Society of Virginia.

Gilbert, Claudette Marie

1979 *Mammoth Hunters: The Domebo Site*. The University of Oklahoma, Oklahoma Archeological Survey.

Goebel, T., Michael R. Waters and Dennis H. O'Rourke

2008 The Late Pleistocene dispersal of modern humans in the Americas. *Science* 319:1497–1502.

Goodyear, Albert C.

1979 *A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleo-Indian Groups of North America*. Research Manuscript Series No. 156. Institute of Archaeology and Anthropology, University of South Carolina, Columbia.

1986 A preliminary report to the National Geographic Society concerning the progress of Grant 3213-85. Excavations of Stratified Early Man Sites, Savannah River Valley. Manuscript on file at the South Carolina Institute of Archaeology and Anthropology, University of South Carolina.

1989 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleoindian Groups of North America. In: *Eastern Paleoindian Lithic Resource Use*, edited by Christopher Ellis and J.C. Lothrop, pp. 1–9. Westview Press, Boulder, Colorado.

1999 The Early Holocene Occupation of the Southeastern United States: A Geoarchaeological Summary. In *Ice Age Peoples of North America: Environments, Origins, and Adaptations of the First Americans*, edited by Robson Bonnichsen and Karen L. Turnmire, pp. 432–481. Corvallis: Oregon State University Press.

2005 Evidence of Pre-Clovis Sites in the Eastern United States. In *New Perspectives on the First Americans*, edited by Bradley T. Lepper, Robson Bonnichsen, Dennis Stanford, and Michael R. Waters, pp.103–112. College Station, Texas: Center for the Study of the First Americans, Texas A&M University Press.

Goodyear, Albert C. and Tommy Charles
1984 *An Archaeological Survey of Chert Quarries in Western Allendale County, South Carolina*. Research Manuscript Series 195. Columbia: South Carolina Institute of Archaeology and Anthropology.

Goodyear, Albert C., III and Kenn Steffy
2003 Evidence of a Clovis occupation at the Topper Site, 38AL23, Allendale County, South Carolina. *Current Research in the Pleistocene* 20:23–25.

Goodyear, Albert C., III, James L. Michie, Tommy Charles
1990 *The Earliest South Carolinians: The Paleoindian Occupation of South Carolina*. Occasional Papers 2. Columbia: Archaeological Society of South Carolina.

1989 The earliest South Carolinians. In: *Studies in South Carolina Archaeology: Essays in Honor of Robert L. Stephenson. III*, edited by Albert C. Goodyear, and Glen T. Hanson. pp. 19–52: Anthropological Studies 9. Columbia: South Carolina. Institute of Archaeology and Anthropology, University of South Carolina.

Goodyear, Albert C., D. Shane Miller, and Ashley M. Smallwood
2007 Introducing Clovis at the Topper Site, 38AL23, Allendale County, South Carolina. Paper presented at the 72nd Annual Meeting of the Society for American Archaeology, April 27, 2007, Austin, Texas.

Goodyear, Albert C, Keith Derting, D. Shane Miller, and Ashley M. Smallwood
2009 Exotic Clovis stone tools from the Topper Site, 38AL23, Allendale County, South Carolina. *Current Research in the Pleistocene,* 26:60–62

Graham, Russell W., C. Vance Haynes, D. L. Johnson, and Marvin Kay
1981 Kimmswick: a Clovis-Mastodon association in eastern Missouri. *Science* 312:1115–1117.

Gramly, Richard M., and Carl Yahnig
1991 The Adams Site (15Ch90) and the Little River, Christian County, Kentucky, Clovis Workshop Complex. *Southeastern Archaeology* 10:134–45.

Green, Frank E.
1963 The Clovis blades: an important addition to the Llano complex. *American Antiquity* 29:145–165.

Haury, Emil W, E. B. Sayles, and William W. Wasley
1959 The Lehner Mammoth site, Southeastern Arizona. *American Antiquity*, 25(1):2–20.

Haynes Jr., C. Vance
1964. Fluted projectile points: Their age and dispersion. *Science*, 145:1408–1413.

1969 The earliest Americans. *Science* 166:709–715.

1980 The Clovis culture. *Canadian Journal of Anthropology*, 1; 115–121.

1982 Were Clovis progenitors in Beringia? In: *The Paleoecology of Beringia*, edited by D. M. Hopkins, J. W. Matthers Jr., C. E. Schwager, and S. B. Young, pp. 383–398. Academic Press, New York.

2005 Clovis, Pre-Clovis, climate change, and extinction. In *Paleoamerican Origins: Beyond Clovis*, edited by Bradley T. Lepper, Robson Bonnichsen, Dennis Stanford, and Michael R. Waters, pp. 113–132. Texas A&M University Press, College Station.

Haynes Jr., C. Vance, and George A. Agogino
1966 Prehistoric springs and geochronology of the Clovis site, New Mexico. *American Antiquity* 31:812–821.

Haynes, Jr., C. Vance, and Bruce B. Huckell
2007 *Murray Springs: A Clovis Site with Multiple Activity Areas in the San Pedro Valley, Arizona*. Anthropological Papers of the University of Arizona No 71. University of Arizona Press, Tucson.

Hemmings, Andrew C.
2004 *The Organic Clovis: A Single Continent-Wide Cultural Adaptation*. Unpublished Ph.D. Dissertation, Department of Anthropology, University of Florida, Gainesville, 2004.

Hester, James
1972 *Blackwater Locality No. 1: A Stratified Early Man Site in Eastern New Mexico*, with sections by Ernest L. Lundelius, Jr. and Roald Fryxell. Fort Burgwin Research Center, Inc., Southern Methodist University, Rancho de Taos, New Mexico.

Hill, Jr., Matthew E.
2002 The Folsom-Age 12 Mile Creek bison bonebed in Western Kansas. *TerQua Symposium Series* 3:53–70. Institute for Tertiary-Quaternary Studies, University of Kansas, Lawrence.

2006 Before Folsom: The 12 Mile Creek site and the debate over the peopling of the Americas. *Plains Anthropologist* 51:141–156

Jelinek, Arthur J.
1981 The Middle Paleolithic in the Southern Levant from the perspective of the Tabun Cave, In *Prehistorie du Levant*, edited by J. Cauvin and P. Sanlaville, pp. 265–280. Editions du CNRS, Paris.

Johnson, Jay K.
1983 Poverty Point period blade technology in the Yazoo Basin, Mississippi. *Lithic Technology 12:(3)* 49–56.

Keeley, Lawrence H.
1974 Technique and methodology in microwear studies: a critical review. *World Archaeology* 5:323–336.

Kelly, Robert L
1988 The three sides of a biface. *American Antiquity* **53**:717–734.

Kelly, Robert .L. and L. C. Todd
1988 Coming into the country: early Paleoindian hunting and mobility. *American Antiquity* 53(2):231–244.

Kilby, J. David
2008 *An Investigation of Clovis Caches: Content, Function, and Technological Organization*. Unpublished Ph.D. Dissertation, Anthropology Department. University of New Mexico, Albuquerque, NM.

Lance, J. F.
1959 Faunal remains from the Lehner Mammoth site. *American Antiquity* 25:35–42.

Logan, Wilfred D.
1952 *Graham Cave: An Archaic Site in Montgomery County, Missouri.* Missouri Archaeological Society Memoir No. 2.

Magne, M.P.
1985 *Lithics and Livelihood: Stone Tool Technologies of Central and Southern British Columbia*. Archaeological Survey of Canada Paper 133. National Museum of Man Mercury Series, Ottawa.

Marcher, Mevin B.
1962 *Geology of the Dover Area, Stewart County, Tennessee*. U.S. Geological Survey, Nashville.

Martin, Paul S.
1973 The discovery of America. *Science* 179:969–974.

1984 Prehistoric overkill: the global model. In: *Quaternary Extinctions: A Prehistoric Revolution,* edited by Paul. S. Martin and R. G. Klein, pp. 354–403. Tucson: Arizona. University of Arizona Press.

McAvoy, Joseph M.
1992 *Nottoway River Survey, Part I: Clovis Settlement Patterns*. Archaeological Society of Virginia Special Publication,28: p. 171.

McAvoy, Joseph M., Lynn D. McAvoy and Cheryl A. Holt.
1997 *Archaeological Investigations of Site 44SX202, Cactus Hill, Sussex County, Virginia*. Department of Human Resources, Richmond, Virginia.

McCary, Ben C.
1951 A workshop site of early man in Dinwiddie County, Virginia. *American Antiquity* 17:9–17.

1975 The Williamson Paleo-Indian Site Dinwiddie County, Virginia. *The Chesopiean* 13:3–4.

Meltzer, David J.
1993 Is there a Clovis adaptation? In *From Kostenki to Clovis: Upper Paleolithic Paleo-Indian Adaptations*, edited by Olga Soffer and N. D. Praslov, pp. 293–310. Plenum Press, New York.

2003 Peopling of North America. *Developments in Quaternary Science* 1:539–563.

Meltzer, David J., and Judith R. Cooper
2005 On morphometric differentiation of Clovis and non-Clovis blades. *Current Research in the Pleistocene* 23:143–145.

Meltzer, David J. and Tom Dillehay, editors
1993 *The First Americans: Search and Research*. CRC Press, Boca Raton.

Michie, James L
1977 E*arly Man in South Carolina*. Unpublished Senior Honors Thesis. Manuscript on file, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia, South Carolina

Miller, D. Shane.
2007 *Site Formation Processes in an Upland Paleoindian Site: The 2006–2007 Topper Firebreak Excavations*. Unpublished Master's Thesis, Anthropology Department, University of Tennessee, Knoxville, Tennessee.

2010 *Clovis Excavations at Topper 2005–2007: Examining Site Formation Processes at an Upland Paleoindian Site along the Middle Savannah River*. Occasional Papers 1, Southeastern Paleoamerican Survey, South Carolina Institute of Archaeology and Anthropology, University of South Carolina. Columbia.

Miller, D. Shane and Ashley M. Smallwood
2009 Beyond Stages: Modeling Clovis Biface Production at the Topper Site (38AL23), South Carolina. Paper presented at the 66th Annual Southeast Archaeology Conference.

Morrow, Juliet E.
1994 A preliminary survey of Iowa Fluted points. *Current Research in the Pleistocene* 11:47–49.

1996 *Organization of Clovis Lithic Technology in the Confluence Region of the Mississippi, Illinois, and Missouri Rivers*. Unpublished Ph.D. Dissertation, Washington University, St. Louis. Univ. Microfilms, Ann Arbor.

Morrow, Juliet, and Toby Morrow
1999 Geographic variation in fluted projectile points; a hemispheric perspective. *American Antiquity* 64(2):215–230.

Mosimann, J. E., and P.S. Martin
1975 Simulating overkill by Paleoindians. *American Scientist.* 63:305–313.

Nelson, Margaret. C.
1991 The Study of Technological Organization. *Archaeological Method and Theory*. 3:57–100.

Newcomer, Mark H.,
1975 Punch technique and Upper Palaeolithic blades. lithic technology making and using stone tools. *World Anthropology,* edited by Earl Swanson, pp. 97–102. Mouton Publishers, The Hague.

Parish, Ryan
2009 *A Chert Sourcing Study Using Visible/Near Infrared Reflectance Spectroscopy at the Dover Quarry Sites, Tennessee*. Unpublished M.A. Thesis, Murray State University.

Parry, William J.
1994 Prismatic blade technologies in North America. In *The Organization of North American Prehistoric Chipped Stone Tool Technologies*, edited by Phillip J. Carr, pp. 87–98. International Monographs in Prehistory, Ann Arbor, Michigan.

Parry, William. J., and Robert L. Kelly
1987 Expedient core technology and sedentism. In: *The Organization of Core Technology*, edited by J. K. Johnson and C. A. Marrow, pp. 284–304. Westview Press, Boulder, Colorado.

Patten, Bob
1999 *Old Tools, New Eyes: A Primal Primer of Flintknapping*. Stone Dagger Publications. Denver, Colorado.

Pearson, Georges A.
2004 Pan-American Paleoindian dispersals and the origins of fishtail projectile points as seen through the lithic raw-material reduction strategies and tool-manufacturing techniques at the Guardiria Site, Turrialba Valley, Costa Rica: In *The Settlement of the American Continents: A Multidisciplinary Approach to Human Biogeography*, edited by C. Michael Barton, Geoffrey A. Clark, David R. Yesner, and Georges A. Pearson, pp. 85–102. University of Arizona Press, Tucson.

Perles, C.
1987 *Les Industries Lithiques Taillees de Franchthi Argolide: Presentation Generale et Industries Paleolithiques*. Indiana University Press, Terre Haute.

Rasic, J, and William Andrefsky.
2001 Alaskan blade cores as specialized components of mobile toolkits: assessing design parameters and toolkit organization through debitage analysis. In: *Lithic Debitage, Context, Form, Meaning* edited by W. Andrefsky, pp. 61–79. University of Utah Press, Salt Lake City.

Sanders, Thomas Nolan
1983 *The Manufacturing of Chipped Stone Tools at a Paleo-Indian Site in Western Kentucky*, Unpublished Master's Thesis. Anthropology Department, University of Kentucky. Lexington, Kentucky.

1990 *Adams: The Manufacturing of Flaked Stone Tools at a Paleoindian Site in Western Kentucky.* Persimmon Press Monographs in Archaeology, Buffalo, New York.

Sellet, Frederick
1993 Chaine operatoire: the concept and its applications. *Lithic Technology*18 (1 and 2).

Sheets, Payson D. and G. Muto
1972 Pressure blades and total cutting edge: an experiment in lithic technology. *Science* 175: 632–634.

Shott, M.J.
1989 On tool class use-lives and the formation of archaeological assemblages. *American Antiquity* 54: 9-30.

1995 Reliability of archaeological records on cultivated surfaces: a Michigan case study. *Journal of Field Archaeology* 22:475-490.

1996 An exegesis of the curation concept. *Journal of Anthropological Research* 52:259-280.

Smallwood, Ashley M.
2010 Clovis biface technology at the Topper Site, South Carolina: evidence for variation and technological flexibility. *Journal of Archaeological Science* 37:2413–2425.

Speth, John. D.
1972 Mechanical basis of percussion flaking. *American Antiquity* 37:34–60.

Stanford, Dennis
1991 Clovis origins and adaptation: an introductory perspective. In *Clovis Origins and Adaptations*, edited by Robson Bonnichsen and Karen L. Turnmire, pp. 1–13. Peopling of the Americas Publications Edited Volume Series. Center for the Study of the First Americans, Oregon State University, Corvallis, Oregon.

Stanford, Dennis J., Elmo Leon Canales, John B. Broster, and Mark R. Norton
2006 Clovis blade manufacture: preliminary data from the Carson-Conn-Short Site (40BN190), Tennessee. *Current Research in the Pleistocene* 23:145–147.

Stanford, Dennis J and Bruce Bradley
2002 Ocean Trails and Prairie Paths? Thoughts about Clovis Origins. In *The First Americans: The Pleistocene Colonization of the New World*, edited by Nina G. Jablonski pp. 255–271. Memoirs of the California Academy of Sciences, No. 27. San Francisco.

Steffy, Ken and Albert C. Goodyear
2006 Clovis macro blades from the Topper Site (38AL23), Allendale County South Carolina. *Current Research in the Pleistocene,* vol. 26.pp. 147–149.

Tankersley, Kenneth B.
1985 The potential for early man sites at Big Bone Lick, Kentucky. *Tennessee Anthropologist* 10(1):27–49.

Tixier, Jacques
1963 *Typologie de l'epipaléolithique du Maghreb*. Mémoires du Centre de Recherches Anthropologiques Préhistoriques et Ethnographiques Alger. II. Paris.

1974 Glossary for the description of stone tools with special reference to the Epipalaeolithic of the Maghreb. *Newsletter of Lithic Technology*: Special Publication Number 1.

Tune, Jesse
2010 *The Wells Creek Clovis? Site: A Reanalysis and Reinterpretation*. Master's Thesis, Department of Anthropology, American University, Washington D.C.

Upchurch, Sam B.
1982 Petrology of selected lithic materials from the South Carolina Coastal Plain. In *An Archaeological Survey of Chert Quarries in Western Allendale County, South Carolina*, by Albert C. Goodyear and Tommy Charles, pp. 125–60. Research Manuscript Series 195, South Carolina Institute of Archaeology and Anthropology, University of South Carolina. Columbia.

Walthall, John A.
1990 *Prehistoric Indians of the Southeast: Archaeology of Alabama and the Middle South*. The University of Alabama, Tuscaloosa.

Waters, Michael R., Steven L. Forman, Thomas W. Stafford Jr., and John Foss
2009 Geoarchaeological investigations at the Topper and Big Pine Sites, Allendale County, central Savannah River, South Carolina. *Journal of Archaeological Science* 36(7):1300–1311.

Waters, Michael R., and Thomas W. Stafford, Jr.
2007 Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 315:1122–1126.

White, Anta M, Lewis R. Binford, and Mark L. Papworth
1963 *Miscellaneous Studies in Typology and Classification*. Museum of Anthropology, University of Michigan Anthropological Papers No. 19. Ann Arbor.

Whittaker, John C.
1994 *Flintknapping Making and Understanding Stone Tools*. The University of Texas, Austin.

Williams, Stephen, and James B. Stoltman
1965 An outline of southeastern United States prehistory with particular emphasis on the Paleo-Indian Era. In *The Quaternary of the United States*, edited by Herbert E. Wright, Jr., and David G. Frey, pp. 669–684. Princeton University Press, Princeton, New Jersey.

Wormington, Hannah Marie
1957 *Ancient Man in North America*. Denver Museum of Natural History, Popular Series 4. Peerless, Denver.

Yahnig, Carl
2004 Lithic technology of the Little River Clovis complex, Christian County, Kentucky. In *New Perspectives on the First Americans,* edited by Bradley T. Lepper; Robson Bonnichsen. College station, Texas A&M University Press. College Station.

APPENDICES

Appendix I	**Technological Attributes of Blades**
Appendix II	**Morphological Attributes of Blades**
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Appendix I

Technological Attributes of Blades

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interp.
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
BHT 15	__	__	Complete	BI	Parallel	Triangular	66	Diffuse	14.49	10.57	11	Blade
N100 E38	5	1	Complete	Multi	Parallel	Triangular	68	Diffuse	9.75	14.53	9	Blade
N100 E40	6	53	Complete	Bi	Parallel	Trapezoidal	67	Diffuse	11.9	7.02	11	Blade
N102 E40	7	34	Complete	Uni	Irregular	Triangular	60	Diffuse	13.29	10.42	9	Blade
N102 E40	8	34	Complete	Bi	Irregular	Triangular	75	Diffuse	11.28	15.51	10	Blade
N102 E42	10	19	Complete	Bi	Parallel	Trapezoidal	63	Diffuse	17.8	5.6	11	Blade
N102 E54	2	2	Complete	Multi	Parallel	Trapezoidal	60	Diffuse	14.95	10.85	8	Blade
N102 E54	2	11	Complete	Multi	Irregular	Triangular	73	Diffuse	10.64	12.14	7	Blade
N104 E48	11	28	Complete	Uni	Parallel	Triangular	NA	NA	2.73	2.43	8	Blade
N104 E48	11	57	Complete	Uni	Irregular	Triangular	61	Diffuse	7.32	6.03	9	Blade
N104 E48	NA	1	Complete	Uni	Irregular	Triangular	65	Diffuse	10.75	13.84	10	Blade
N104 E48	11	4	Complete	Uni	Parallel	Triangular	75	None	4.64	2.05	11	Blade
N104 E48	11	64	Complete	Uni	Parallel	Triangular	67	Diffuse	6.28	2.68	11	Blade
N104 E48	11	31	Complete	Bi	Parallel	Trapezoidal	67	None	15.85	13.4	11	Blade
N104 E48	10	?	Complete	Bi	Parallel	Triangular	71	Diffuse	5.99	9.48	12	Blade
N104 E48	11	67	Complete	Uni	Parallel	Trapezoidal	87	None	3.08	4.21	12	Blade
N104 E50	10	3	Complete	Uni	Parallel	Trapezoidal	NA	NA	6.19	4.25	8	Blade
N114 E50	10	16	Complete	Uni	Irregular	Triangular	55	Diffuse	6.47	5.1	7	Blade
N114 E50	7	2	Complete	Uni	Parallel	Triangular	75	None	6.73	4.4	11	Blade
N138 E36	5	31	Complete	Uni	Parallel	Triangular	NA	NA	8.87	4.7	8	Blade
N138 E36	6	17	Complete	Uni	Parallel	Lenticular	73	Diffuse	4.3	4.34	9	Blade
N138 E36	7	37	Complete	Uni	Parallel	Trapezoidal	64	Diffuse	5.8	4.14	11	Blade
N138 E36	5	19	Complete	Uni	Parallel	Trapezoidal	78	Diffuse	5.89	3.44	11	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes							Interpretation	
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N144 E42	10	11	Complete	Bi	Parallel	Triangular	NA	NA	5.79	2.82	8	Blade
N148 E48	10	10	Complete	Uni	Irregular	Triangular	NA	Diffuse	13.95	6.6	7	Blade
N152 E 50	10	11	Complete	Uni	Parallel	Lenticular	65	Diffuse	14.76	9.12	8	Blade
N158 E56	TT	63	Complete	Uni	Parallel	Triangular	60	None	8.94	3.63	11	Blade
N158 E56	TT	59	Complete	Uni	Parallel	Triangular	63	None	8.76	10.39	12	Blade
N160 E56	TT	4	Complete	Uni	Irregular	Triangular	80	None	14.79	9.71	9	Blade
N170 E62	10	123	Complete	Uni	Irregular	Trapezoidal	59	Diffuse	8.4	NA	7	Blade
N170 E62	9	135	Complete	Uni	Parallel	Triangular	NA	NA	NA	10.98	8	Blade
N170 E62	9	112	Complete	Uni	Parallel	Triangular	NA	NA	8.83	9.44	9	Blade
N170 E62	10	106	Complete	Uni	Parallel	Trapezoidal	62	Diffuse	14.44	7.03	11	Blade
N170 E62	9	179	Complete	Uni	Parallel	Triangular	69	Diffuse	7.02	7.44	12	Blade
N172 E62	10	34	Complete	Uni	Parallel	Lenticular	63	NA	12.9	6.17	7	Blade
N172 E62	10	80	Complete	Uni	Parallel	Lenticular	76	None	6.27	3.74	8	Blade
N172 E62	10	70	Complete	Uni	Parallel	Lenticular	66	Diffuse	13.53	8.88	8	Blade
N172 E62	11	6	Complete	Uni	Parallel	Triangular	NA	NA	8.09	9.27	9	Blade
N172 E62	9	25	Complete	Uni	Parallel	Triangular	58	None	3.29	4.06	10	Blade
N234 E106	8		Complete	Uni	Parallel	Trapezoidal	63	Diffuse	11.04	8.3	11	Blade
N238 E134	3	01-134	Complete	Uni	Irregular	Triangular	57	None	4.76	2.97	7	Blade
N238 E134	3	01-131	Complete	Uni	Irregular	Trapezoidal	62	Diffuse	6.7	4.5	9	Blade
N242 E128	8	7	Complete	Uni	Parallel	Triangular	65	Diffuse	4.33	2.63	11	Blade
N246 E142	4	5	Complete	Uni	Parallel	Triangular	60	Diffuse	5.21	3.68	11	Blade
N284 E134	9	23	Complete	Uni	Parallel	Lenticular	61	Diffuse	3.33	NA	8	Blade
N284 E134	11	B	Complete	Uni	Parallel	Triangular	59	Diffuse	7.49	4.14	9	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes							Interpretation	
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N284 E134	9	14	Complete	Uni	Parallel	Triangular	63	Salient	4.63	3.61	10	Blade
N284 E134	10	35	Complete	Uni	Parallel	Trapezoidal	65	Diffuse	1.77	NA	11	Blade
N286 E 136	10	29	Complete	Uni	Irregular	Triangular	75	Diffuse	5.39	4.75	9	Blade
N286 E 136	10	32	Complete	Uni	Parallel	Triangular	67	None	5.22	4.91	11	Blade
N286 E 138	12	A	Complete	Uni	Parallel	Triangular	63	Diffuse	4.66	4.52	11	Blade
N286 E132	11	1	Complete	Uni	Irregular	Triangular	77	Diffuse	5.79	4.81	9	Blade
N286 E134	9	37	Complete	Uni	Parallel	Triangular	NA	NA	NA	4.06	8	Blade
N286 E134	10	1	Complete	Uni	Irregular	Triangular	65	Diffuse	4.4	4.28	9	Blade
N286 E134	9	34	Complete	Uni	Parallel	Triangular	83	Diffuse	3.84	3.46	11	Blade
N286 E134	8	A	Complete	Uni	Parallel	Triangular	65	Diffuse	4.29	5.42	12	Blade
N286 E134	8	B	Complete	Uni	Irregular	Triangular	NA	NA	3.19	3.51	7	Blade
N286 E134	9	36	Complete	Uni	Parallel	Triangular	NA	NA	NA	5.49	8	Blade
N286 E134	12	2	Complete	Uni	Parallel	Triangular	57	Diffuse	3.95	3.38	9	Blade
N286 E134	9	33	Complete	Uni	Irregular	Triangular	71	Diffuse	5.75	3.92	9	Blade
N286 E134	9	26	Complete	Uni	Irregular	Triangular	68	None	4.41	5.15	10	Blade
N286 E136	10	27	Complete	Uni	Irregular	Trapezoidal	72	None	4.79	3.88	9	Blade
N286 E136	10	68	Complete	Uni	Irregular	Triangular	68	Diffuse	4.21	4.06	9	Blade
N286 E138	10	2	Complete	Uni	Parallel	Triangular	NA	None	4.6	2.63	9	Blade
N286 E138	12	A	Complete	Uni	Irregular	Triangular	78	None	10.58	7.46	9	Blade
N286 E138	12	1	Complete	Uni	Parallel	Triangular	78	Diffuse	7.67	10.71	12	Blade
N286 E138	12	F	Complete	Bi	Irregular	Triangular	NA	NA	5.49	8.57	7	blade
N286 E138	12	C	Complete	Uni	Parallel	Triangular	NA	NA	8.81	4.59	8	Blade
N286 E138	13	B	Complete	Uni	Irregular	Trapezoidal	64	Diffuse	2.24	4.25	10	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N286 E138	12	E	Complete	Uni	Parallel	Triangular	71	Diffuse	6.94	6.27	11	Blade
N286 E138	12	J	Complete	Uni	Parallel	Triangular	63	None	5.5	5.52	11	Blade
N286 E138	12	G	Complete	Uni	Parallel	Triangular	64	Diffuse	15.5	16.37	12	blade
N288 E136	7	1	Complete	Uni	Parallel	Triangular	78	None	16.08	11.56	11	Blade
N290 E132	12	2	Complete	Bi	Parallel	Trapezoidal	54	None	10.05	5.99	9	Blade
N290 E132	10	4	Complete	Uni	Parallel	Triangular	65	NA	5.06	4.16	10	Blade
N76 E182			Complete	Uni	Irregular	Triangular		None			7	Blade
TU 04	4		Complete	Uni	Irregular	Triangular	59	Diffuse	21.36	10.16	7	Blade
TU 04	4		Complete	Bi	Irregular	Trapezoidal	67	Salient	6.56	6.35	8	Blade
TU 04	4	18	Complete	Uni	Parallel	Triangular	67	Diffuse	8.21	7.85	11	Blade
TU 04	5	3	Complete	Bi	Parallel	Triangular	75	Diffuse	11.72	5.48	11	Blade
TU 04	2	31	Complete	Uni	Parallel	Triangular	77	Diffuse	6.12	5.37	11	Blade
TU 04			Complete	Bi	Irregular	Triangular	55	Diffuse	8.26	4.77	7	Blade
TU 04	1	9	Complete	Bi	Parallel	Lenticular	70	None	12.32	6	8	Blade
TU 04	2	33	Complete	Uni	Parallel	Triangular	NA	NA	3.93	5.07	9	Blade
TU 04	2	26	Complete	Uni	Parallel	Triangular	72	Salient	6	5.6	10	Blade
TU 04	4	2	Complete	Bi	Parallel	Triangular	77	Diffuse	9.9	7.62	11	Blade
TU 04	4	22	Complete	Uni	Parallel	Triangular	73	None	6.63	6.22	11	Blade
TU 04	2	14	Complete	Uni	Parallel	Triangular	68	Diffuse	4.02	3.76	11	Blade
TU 10	2	21	Complete	Uni	Parallel	Triangular	60	Diffuse	7.52	6.29	11	Blade
TU 10	2	18	Complete	Uni	Parallel	Triangular	68	Diffuse	15.01	9.17	11	Blade
TU 11	2	2	Complete	Uni	Parallel	Trapezoidal	NA	NA	10.6	4.81	8	Blade
TU 11	2	1	Complete	Bi	Irregular	Triangular	78	None	4.78	9.46	10	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
TU 11	2	13	Complete	Uni	Parallel	Trapezoidal	58	Diffuse	4.25	4.34	10	Blade
TU 11	2	11	Complete	Bi	Parallel	Trapezoidal	69	Diffuse	5.45	5.92	12	Blade
TU 11	2	9	Complete	Uni	Parallel	Trapezoidal	71	None	6.39	3.24	11	Blade
TU 5	4	A	Complete	Uni	Irregular	Triangular	65	NA	7.75	7.21	9	Blade
TU 5	3	C	Complete	Uni	Parallel	Triangular	NA	None	6.21	2.94	8	Blade
TU 5	3	F	Complete	Uni	Irregular	Triangular	65	None	7.57	5.55	9	Blade
TU 5	4	2	Complete	Uni	Irregular	Trapezoidal	69	Diffuse	7.51	6.26	9	Blade
TU 5	4	4	Complete	Bi	Parallel	Trapezoidal	65	Diffuse	5.94	4.18	11	Blade
TU 5	3	A	Complete	Uni	Parallel	Triangular	62	Salient	4.3	4.18	11	Blade
TU 6	4	3	Complete	Uni	Irregular	Triangular	60	Diffuse	11.32	5.48	8	Blade
TU 6	3	B	Complete	Uni	Parallel	Triangular	67	Diffuse	9.08	6.71	11	Blade
TU 6	3	D	Complete	Uni	Parallel	Triangular	67	Diffuse	4.74	4.96	12	Blade
TU 7	5	20	Complete	Uni	Irregular	Triangular	73	Diffuse	3.41	5.72	10	Blade
TU 7	6	3	Complete	Uni	Parallel	Triangular	74	Diffuse	4.48	4.07	11	Blade
TU 7	3	F	Complete	Uni	Parallel	Triangular	70	None	6.58	4.82	11	Blade
TU 7	4	F	Complete	Uni	Parallel	Triangular	90	Diffuse	7.02	5.67	11	Blade
TU 7	3	2	Complete	Uni	parallel	Triangular	90	Diffuse	4.08	5.39	12	Blade
TU 9	2	5	Complete	Uni	Irregular	Lenticular	75	Diffuse	4.31	7.23	7	Blade
TU 9	2	A	Complete	Uni	Irregular	Triangular	64	None	4.15	3.32	9	Blade
TU 9	2	G	Complete	Uni	Parallel	Triangular	58	None	4.18	4.01	9	Blade
N240 E128	5	01-162	Complete	Bi	Parallel	Triangular	73	NA	2.73	1.88	11	Blade
N244 E136	6	1	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N160 E56	TT	51	Medial	Uni	Parallel	Trapezoidal	NA		NA	NA	8	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N104 E50	10	20	Complete	Bi	Parallel	Triangular	72	None	15.67	16.52	12	Blade, corn.
TU 04	2	22	Complete	Uni	parallel	Triangular	55	Diffuse	11.58	17.26	10	Blade, corn.
TU 04	4	25	Complete	Uni	Parallel	Triangular	67	None	8.61	10.62	12	Blade, cor.
TU 5	3	D	Complete	Uni	Parallel	Triangular	62	None	6.41	4.11	11	Blade, corn.
TU 5	5	2	Complete	Uni	Parallel	Triangular	63	None	10.3	4.33	11	Blade, corn.
TU 7	4	C	Complete	Uni	Parallel	Triangular	NA	NA	7.38	4.59	8	Blade, corn.
TU 7	5	A	Complete	Bi	Irregular	Triangular	70	None	7.77	10.45	10	Blade, corn.
N122 E64	9	104	Complete	Bi	parallel	Triangular	NA	NA	9.52	7.27	8	Blade, crest
N138 E36	8	1	Complete	Multi	Parallel	Triangular	69	Diffuse	12.45	20.33	9	Blade, crest
N152 E50	10	12	Complete	Uni	Parallel	Triangular	71	Diffuse	8.7	7.21	11	Blade, crest
N170 E62	9	96	Complete	Bi	Parallel	Triangular	60	Diffuse	11.71	11.61	11	Blade, crest
N172 E62	10	63	Complete	Multi	Parallel	Triangular	64	None	15.9	10.79	8	Blade, crest
Roadbed			Complete	Multi	Irregular	Triangular	81	Diffuse	21.41	10.54	9	Blade, crest
Roadbed			Complete	Multi	Parallel	Triangular	68	Diffuse			9	Blade, crest
TU 04	5	2	Complete	Uni	Parallel	Triangular	78	Diffuse	7.3	4.05	11	Blade, crest
TU 6	3	6	Complete	Bi	Irregular	Triangular	NA	NA	9.74	12.36	7	Blade, crest
TU 6	4	1	Complete	Uni	Irregular	Triangular	65	None	5.83	7.37	10	Blade, crest
TU 8	6	8	Complete	Multi	parallel	Triangular	NA	NA	11.96	9.11	8	Blade, crest
N144 E42	10	57	Distal	Bi	Parallel	Trapezoidal	NA	Diffuse	NA	3.77	9	Blade
N144 E42	10	Screen	Distal	Uni	Parallel	Triangular	NA	None	5.2	5.75	10	Blade
N148 E48	9	35	Distal	Uni	Parallel	Triangular	NA	NA	NA	6.02	8	Blade
N242 E128	9	12	Distal	Bi	Parallel	Triangular	NA	NA	NA	2.91	8	Blade
N242 E128	9	10	Distal	Uni	Parallel	Triangular	NA	NA	NA	6.56	8	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N244 E136	6	2	Distal	Uni	Parallel	Trapezoidal	NA	NA	NA	2.02	8	Blade
N284 E134	11	A	Distal	Uni	Parallel	Triangular	NA	NA	NA	3.64	8	Blade
N284 E134	10	34	Distal	Uni	Parallel	Trapezoidal	NA	NA	NA	2.25	8	Blade
N286 E134	9	39	Distal	Uni	Parallel	Triangular	NA	NA	3.5	NA	8	Blade
N286 E138	12	B	Distal	Bi	Parallel	Trapezoidal	NA	NA	NA	3.46	8	Blade
TU 04	4	5	Distal	Uni	Parallel	Triangular	NA	NA	NA	5.33	8	Blade
TU 04	2	28	Distal	Uni	Parallel	Triangular	NA	NA	NA	3.91	8	Blade
TU 10	2	27	Distal	Uni	Parallel	Triangular	NA	NA	NA	7.3	8	Blade
TU 5	3	H	Distal	Uni	Parallel	Triangular	NA	NA	NA	3.94	8	Blade
TU 7	3	B	Distal	Uni	Parallel	Triangular	NA	NA	NA	4.67	8	Blade
TU 8	5	4	Distal	Uni	Parallel	Triangular	NA	NA	NA	5.31	8	Blade
N104 E48	11	37	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N104 E50	9	5	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N104 E50	10	21	Medial	Uni	Parallel	Triangular	NA	None	NA	NA	9	Blade
N148 E48	9	18	Medial	Bi	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N150 E 50	10	8	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N150 E150	10	8	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N158 E56	TT	71	Medial	Bi	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N158 E56	TT	50	Medial	Uni	Parallel	Triangular	NA	None	NA	NA	9	Blade
N158 E56	TT	12	Medial	Uni	Parallel	Triangular	NA	None	NA	NA	9	Blade
N160 E56	TT	49	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N170 E62	9	34	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N170 E62	9	47	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N242 E128	9	3	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N242 E128	9	9	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N276 E152	4	2	Medial	Bi	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N284 E134	10	32	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N284 E134	10	52	Medial	Bi	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N284 E134	9	26	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N286 E134	7	A	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N286 E134	9	13	Medial	Bi	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N286 E138	12	D	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N286 E138	9	B	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N286 E138	9	C	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N286 E138	13	D	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
N288 E136	12	5	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
Roadbed			Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
TU 04	4	11	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
TU 04	4	14	Medial	Uni	Parallel	Trapezoidal	NA	None	NA	NA	9	Blade
TU 04	4		Medial	Uni	Parallel	Triangular	NA	None	NA	NA	9	Blade
TU 10	2	31	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
TU 6	5	B	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
TU 6	3	C	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
TU 7	4	B	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
TU 7	4	D	Medial	Uni	Parallel	Trapezoidal	NA	NA	NA	NA	8	Blade
TU 7	4	J	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
TU 7	6	F	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
TU 7	6	G	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
TU 9	2	B	Medial	Uni	Parallel	Triangular	NA	NA	NA	NA	8	Blade
N100 E40	7	6	Proximal	Bi	Parallel	Triangular	70	Diffuse	6.54	NA	11	Blade
N100 E62	8	5	Proximal	Uni	Irregular	Triangular	64	Diffuse	7.84	NA	9	Blade
N102 E64	6	13	Proximal	Uni	Parallel	Triangular	72	Diffuse	9.03	NA	11	Blade
N122 E64	8	122	Proximal	Uni	Parallel	Trapezoidal	75	NA	5.87	NA	10	Blade
N138 E36	7	33	Proximal	Uni	Irregular	Triangular	65	Diffuse	11.13	NA	9	Blade
N138 E36	5	1	Proximal	Uni	Parallel	Triangular	65	NA	7.26	NA	10	Blade
N138 E36	8	16	Proximal	Uni	Parallel	Triangular	72	Diffuse	11.38	NA	11	Blade
N138 E36	6	29	Proximal	Uni	Parallel	Triangular	63	Diffuse	8.13	NA	11	Blade
N144 E42	11	12	Proximal	Uni	Parallel	Trapezoidal	62	Diffuse	8.6	NA	11	Blade
N144 E42	10	7	Proximal	Uni	Parallel	Triangular	70	Diffuse	5.14	NA	11	Blade
N148 E48	10	11	Proximal	Uni	Parallel	Triangular	65	Diffuse	9.63	NA	11	Blade
N160 E56	TT	53	Proximal	Uni	Parallel	Triangular	65	Diffuse	11.49	8.29	11	Blade
N170 E 62	10	15	Proximal	Uni	Parallel	Triangular	56	Diffuse	7.16	NA	9	Blade
N170 E62	9	98	Proximal	Uni	Parallel	Trapezoidal	72	NA	5.39	NA	10	Blade
N170 E62	9	62	Proximal	Uni	Parallel	Triangular	65	Diffuse	10.65	NA	11	Blade
N170 E62	9	41	Proximal	Uni	Parallel	Trapezoidal	68	Diffuse	10.7	NA	11	Blade
N170 E62	10	52	Proximal	Uni	Parallel	Triangular	60	Diffuse	8.88	NA	11	Blade
N242 E128	9	8	Proximal	Uni	Parallel	Trapezoidal	71	None	5.64	NA	11	Blade
N244 E128	9	1	Proximal	Uni	Parallel	Triangular	77	None	3.54	3.6	12	Blade
N284 E 136	10	13	Proximal	Multi	Parallel	Triangular	60	Diffuse	12.9	NA	8	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N284 E134	10	12	Proximal	Bi	Irregular	Trapezoidal	74	Diffuse	31.32	4.39	9	Blade
N284 E134	10	?	Proximal	Uni	Parallel	Triangular	50	Diffuse	31.89	6.79	9	Blade
N286 E134	9	13	Proximal	Uni	Parallel	Trapezoidal	NA	NA	11.31	4.25	8	Blade
N286 E134	7	B	Proximal	Uni	Parallel	Trapezoidal	57	Diffuse	12.75	2.6	10	Blade
N286 E134	9	32	Proximal	Uni	Parallel	Trapezoidal	63	Diffuse	21.22	4.55	11	Blade
N286 E138	12	B	Proximal	Bi	Parallel	Triangular	79	Diffuse	34.33	7.96	11	Blade
N286 E138	13	1	Proximal	Uni	Parallel	Triangular	60	Diffuse	47.1	8.31	11	Blade
N286 E138	14	8	Proximal	Bi	Parallel	Triangular	64	Diffuse	33.06	9.18	11	Blade
N286 E138	12	I	Proximal	Uni	Parallel	Triangular	65	Diffuse	23.61	6.61	11	Blade
N286 E138	14	A	Proximal	Uni	Parallel	Triangular	60	Diffuse	31.19	6.05	11	Blade
Roadbed		16	Proximal	Uni	Parallel	Trapezoidal	65	Diffuse	35.52	7.23	11	Blade
TU 04	5	7	Proximal	Uni	Parallel	Triangular	65	Diffuse	28.71	7.22	11	Blade
TU 04	4	9	Proximal	Uni	Parallel	Triangular		Diffuse	26.13	5.74	9	Blade
TU 04	5	6	Proximal	Bi	Parallel	Triangular	80	Diffuse	32.63	7.14	11	Blade
TU 04	4		Proximal	Uni	Parallel	Trapezoidal	62	Diffuse	20.9	6.64	11	Blade
TU 04	4		Proximal	Bi	Parallel	Triangular	65	None	26.68		**11**	Blade
TU 10	2	14	Proximal	Uni	Irregular	Triangular	NA	Diffuse	24.94	4.47	7	Blade
TU 10	2	25	Proximal	Uni	Parallel	Triangular	67	Diffuse	30.48	7.3	11	Blade
TU 11	2	16	Proximal	Uni	Irregular	Trapezoidal	77	Diffuse	34.17	4.69	9	Blade
TU 11	2	1	Proximal	Bi	Irregular	Triangular	67	None	36.9	4.59	9	Blade
TU 11	2	4	Proximal	Multi	Parallel	Triangular	80	Diffuse	16.24	6.99	8	Blade
TU 5	4	3	Proximal	Uni	Irregular	Trapezoidal	64	Diffuse	36.11	7.85	9	Blade
TU 5	3	B	Proximal	Uni	Parallel	Lenticular	67	Diffuse	20.73	7.74	8	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
TU 6	3	1	Proximal	Uni	Irregular	Triangular	63	None	6.7	NA	9	Blade
TU 6	5	A	Proximal	Uni	Parallel	Trapezoidal	65	None	3.91	NA	11	Blade
TU 6	5	C	Proximal	Uni	Parallel	Triangular	66	Diffuse	5.38	NA	11	Blade
TU 7	6	1	Proximal	Bi	Irregular	Triangular	60	Diffuse	3.72	NA	9	Blade
TU 7	4	2	Proximal	Uni	Parallel	Triangular		None	4.64	NA	9	Blade
TU 7	4	H	Proximal	Uni	Irregular	Trapezoidal	70	Diffuse	3.78	NA	9	Blade
TU 7	6	2	Proximal	Uni	Parallel	Triangular	73	NA	3.5	NA	10	Blade
TU 7	5	16	Proximal	Multi	Parallel	Triangular	60	Diffuse	6.68	NA	8	Blade
TU 7	4	E	Proximal	Uni	Irregular	Triangular	78	Diffuse	3.98	NA	9	Blade
TU 7	6	E	Proximal	Uni	Irregular	Triangular	60	None	3.02	NA	9	Blade
TU 7	4	I	Proximal	Uni	Parallel	Trapezoidal	65	Diffuse	6.14	NA	11	Blade
TU 7	6	B	Proximal	Uni	Parallel	Triangular	64	Diffuse	3.84	NA	11	Blade
TU 9	2	16	Proximal	Uni	Irregular	Triangular	60	Diffuse	9.49	5.42	9	Blade
TU 9	2	15	Proximal	Uni	Parallel	Triangular	65	Diffuse	7.55	NA	11	Blade
TU 9	2	C	Proximal	Uni	Parallel	Triangular	76	None	2.87	NA	11	Blade
TU 9	2	F	Proximal	Uni	Parallel	Triangular	70	Diffuse	3.79	NA	11	Blade
TU 9	2	6	Proximal	Uni	Irregular	Triangular	68	Diffuse	6.15	NA	9	Blade
N150 E 50	10	10	Proximal	Uni	Parallel	Triangular	56	Diffuse	5.19	NA	9	Blade
N104 E48		1	complete	Uni	Parallel	Triangular	65	Diffuse	10.92	8.49	11	Blade
N284 E134	9	21	complete	Uni	parallel	Triangular	NA	NA	14.28	5.84	8	Blade
N286 E134	9	4	complete	Uni	Parallel	Triangular	NA	NA	7.89	10.1	9	Blade
TU 10	2	22	complete	Bi	Irregular	Trapezoidal	74	Diffuse	21.09	10.66	9	Blade
TU 5	3	E	complete	Uni	Parallel	Triangular	73	None	10.33	3.94	11	Blade

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
TU 7	4	A	Complete	Parallel	Uni	Triangular	58		Diffuse	3.46	9	Blade
TU 8	5	2	Complete	Parallel	Bi	Triangular	NA		None	9.26	9	Blade
N122 E64	8	103	Complete	Parallel	Uni	Triangular	59		Diffuse	6.41	9	Blade
N284 E134	9	29	Complete	Irregular	Uni	Lenticular	59		Salient	2.47	3	BLF
N104 E48	11	19	Complete	Irregular	Multi	Triangular	60		Diffuse	10.26	6	BLF
N1152 E50			Complete		Multi	Triangular			NA		3	BLF
N138 E36	8	3	Complete	Irregular	Bi	Lenticular	NA		NA	5.9	3	BLF
N138 E36	7	27	Complete	Irregular	Uni	Lenticular	NA		NA	NA	3	BLF
N144 E42	10	24	Complete	Irregular	Uni	Triangular	NA		NA	5.9	6	BLF
N144 E42	11	43	Complete	Irregular	Multi	Triangular	69		Diffuse	6.61	6	BLF
N148 E48	9	15	Complete	Irregular	Multi	Lenticular	75		Diffuse	3.25	4	BLF
N148 E48	9	8	Complete	Irregular	Multi	Trapezoidal	64		None	5.91	6	BLF
N150 E50	10	1	Complete	Irregular	Multi	Lenticular	58		Diffuse	4.1	1	BLF
N150E50	10	4	Complete	Irregular	Multi	Lenticular	NA		NA	2.98	0	BLF
N152 E50			Complete	Irregular	Multi	Lenticular	61		None	6.72	3	BLF
N152 E50	10	5	Complete	Parallel	Uni	Lenticular	58		None	6.33	6	BLF
N158 E56			Complete	Irregular	Multi	Triangular			Diffuse		4	BLF
N158 E56	TT	9	Complete	Irregular	Multi	Triangular	71		None	13.25	6	BLF
N170 E 62	10	8	Complete	Parallel	Uni	Lenticular	NA		NA	2.86	5	BLF
N170 E62	10	107	Complete	Parallel	Uni	Lenticular	NA		NA	3.37	5	BLF
N170 E62	9	113	Complete	Irregular	Uni	Triangular	NA		NA	4.18	6	BLF
N170 E62	9	175	Complete	Irregular	Multi	Triangular	70		Diffuse	6.56	6	BLF
N172 E62	9	15	Complete	Irregular	Multi	Triangular	61		NA	4.75	5	BLF

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Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N242 E128	8	1	Complete	Bi	Irregular	Lenticular	60	Diffuse	4.78	2.58	6	BLF
N284 E134	9	17	Complete	Uni	Irregular	Lenticular	67	Diffuse	2.06	1.26	6	BLF
N284 E134	10	14	Complete	Multi	Irregular	Lenticular	57	None	13.55	6.81	1	BLF
N284 E134	10	8	Complete	Multi	Irregular	Lenticular	68	Diffuse	4.22	8.4	4	BLF
N284 E134	10	19	Complete	Uni	Irregular	Lenticular	78	None	7.88	3.7	6	BLF
N284 E134	9	16	Complete	Uni	Parallel	Lenticular	54	Diffuse	5.69	3.05	6	BLF
N286 E134	10	27	Complete	Uni	Irregular	Lenticular	NA	Diffuse	5.27	4.94	4	BLF
N286 E134	9	12	Complete	Uni	Irregular	Lenticular	NA	NA	5.87	8.53	4	BLF
N286 E136	10	41	Complete	Bi	Irregular	Lenticular	NA	NA	6.12	2.52	3	BLF
N286 E136	10	69	Complete	Uni	Irregular	Triangular	NA	NA	NA	NA	6	BLF
N286 E138	9	A	Complete	Uni	Irregular	Lenticular	53	Diffuse	2.87	2.51	4	BLF
N286 E138	12	H	Complete	Multi	Parallel	Lenticular	60	Diffuse	4.07	2.2	5	BLF
N286 E138	13	C	Complete	Uni	Irregular	Lenticular	60	None	7.13	3.46	6	BLF
TU 11	2	17	Complete	Multi	Irregular	Triangular	75	Diffuse	10.07	7.05	6	BLF
TU 7	4	4	Complete	Multi	Parallel	Lenticular	75	Diffuse	5.03	3.82	5	BLF
TU 7	3	D	Complete	Multi	Irregular	Lenticular	73	Diffuse	6.38	5	3	BLF
TU 7	3	E	Complete	Multi	Irregular	Lenticular	74	Diffuse	5.32	1.91	3	BLF
TU 7	3	C	Complete	Uni	Irregular	Triangular	NA	NA	3.86	3.76	6	BLF
TU 9	2	E	Complete	Uni	Irregular	Lenticular	NA	NA	3.13	3.12	3	BLF
TU 9	2	D	Complete	Uni	Irregular	Triangular	53	Salient	7.54	5.03	6	BLF
TU 6	3	A	Complete	Uni	Irregular	Triangular	61	Diffuse	7.93	7.82	6	BLF, corn.
N144 E42	11	2	Complete	Multi	Irregular	Triangular	67	Diffuse	11.67	7.6	6	BLF crest
N150 E50	10	9	Complete	Multi	Irregular	Lenticular	NA	Diffuse	5.05	7.45	2	BLF crest

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Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat Angle	Bulb	Th(prox)	Th(dist)		
N284 E134	10	26	Complete	Multi	Irregular	Triangular	78	None	13.14	6.67	6	BLF crest
TU 7	3	3	Complete	Multi	Irregular	Triangular	76	Diffuse	9.56	5.68	6	BLF crest
N286 E136	10	6	Complete	Multi	Irregular	Lenticular	75	None	8.56	5.38	3	BLF crest
N100 E38	7	9	Distal	Multi	Parallel	Triangular	NA	NA	11.56	15.71	6	BLF
N104 E50	10	2	Distal	Uni	Irregular	Triangular	NA	NA	NA	3.99	6	BLF
N158 E56	TT	57	Distal	Uni	Irregular	Lenticular	NA	NA	NA	6.15	3	BLF
N172 E62	10	2	Distal	Multi	Irregular	Lenticular	NA	NA	NA	4.01	0	BLF
N234 E106			Distal	Multi	Parallel	Trapezoidal	NA	NA	NA	5.92	5	BLF
N242 E128	9	13	Distal	Uni	Irregular	Triangular	NA	NA	NA	4.58	6	BLF
N284 E134	9	20	Distal	Uni	Irregular	Lenticular	NA	NA	NA	5.9	3	BLF
N286 E138	13	A	Distal	Uni	Irregular	Triangular	NA	NA	NA	3.42	6	BLF
N286 E138	12	C	Distal	Uni	Irregular	Trapezoidal	NA	NA	NA	3.14	6	BLF
TU 04	2	7	Distal	Uni	Irregular	Lenticular	NA	NA	NA	1.83	3	BLF
TU 10	2	26	Distal	Bi	Parallel	Lenticular	NA	NA	NA	4.5	5	BLF
TU 10	2	23	Distal	Uni	Irregular	Trapezoidal	NA	NA	NA	NA	6	BLF
TU 5	3	G	Distal	Uni	Irregular	Triangular	NA	NA	NA	4.85	6	BLF
TU 7	3	A	Distal	Uni	Irregular	Triangular	NA	NA	NA	3.58	6	BLF
TU 7	6	D	Distal	Bi	Irregular	Trapezoidal	NA	NA	3.94	NA	6	BLF
N160 E56	TT	45	Medial	Multi	Irregular	Triangular	NA	NA	6.71	5.68	3	BLF
N172 E62	10	52	Medial	Uni	Parallel	Lenticular	NA	NA	NA	NA	5	BLF
N172 E62	10	16	Medial	Uni	Parallel	Lenticular	NA	NA	NA	NA	5	BLF
N284 E134	9	34	Medial	Uni	Parallel	Lenticular	NA	NA	NA	NA	5	BLF
N284 E134	9	7	Medial	Uni	Irregular	Triangular	NA	NA	NA	NA	6	BLF

Appendix I. Technological Attributes of Blades

Provenience			Portion	Technological Attributes								Interpretation
Unit	Level	Art#		Directionality	Margin	Cross Sec.	Plat An-gle	Bulb	Th(prox)	Th(dist)		
N286 E136	10	28	Medial	Uni	Parallel	Lenticular	NA	NA	NA	NA	5	BLF
Roadbed		5	Medial	Multi	Parallel	Trapezoidal	NA	NA	NA	NA	5	BLF
TU 6	3	E	Medial	Uni	Irregular	Triangular	NA	NA	NA	NA	6	BLF
TU 7	6	C	Medial	Uni	Irregular	Lenticular	NA	NA	NA	NA	3	BLF
TU 7	6	H	Medial	Uni	Parallel	Lenticular	NA	NA	NA	NA	5	BLF
TU 7	4	G	Medial	Uni	Irregular	Triangular	NA	NA	NA	NA	6	BLF
N138 E36			Proximal	Uni	Irregular	Lenticular		None			4	BLF
N138 E36	5	3	Proximal	Uni	Parallel	Lenticular	NA	Diffuse	3.69	NA	6	BLF
TU 7	6	4	Proximal	NA	Irregular	Triangular	63	Diffuse	2.81	NA	5	BLF
TU 7	5	19	Proximal	Multi	Irregular	Triangular	70	Diffuse	4.3	NA	6	BLF

Appendix II.

Morphological Attributes of Blades

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
BHT 15	__	__	Complete		99.24	28.46	7.4	7.4	6.55	2	11	Blade
N100 E38	5	1	Complete	45.61	112.62	34.13	9.84	10.97	5.51	10	9	Blade
N100 E40	6	53	Complete	57.13	125.24	40.25	8.84	20.03	7.62	4	11	Blade
N102 E40	7	34	Complete	41.42	111.05	30.39	6.76	25.83	14.63	1	9	Blade
N102 E40	8	34	Complete	47.8	95.23	33.74	7.45	14.62	6.48	7	10	Blade
N102 E42	10	19	Complete	45.27	106	32.64	15.95	7.91	3.26	7	11	Blade
N102 E54	2	2	Complete	161.08	141.38	67.2	9.05	27.74	8.72	15	8	Blade
N102 E54	2	11	Complete	38.06	95.14	36.09	4.1	24.98	6.36	5	7	Blade
N104 E48	11	28	Complete	1.33	40.69	14.32	2.33	NA	NA	3	8	Blade
N104 E48	11	57	Complete	13.76	72.36	28.91	9.78	14.7	5.68	5	9	Blade
N104 E48	NA	1	Complete	114.7	139.73	58.22	7.9	15.08	6.77	8	10	Blade
N104 E48	11	4	Complete	2.2	39.3	13.97	4.5	8.89	4.04	4	11	Blade
N104 E48	11	64	Complete	5.23	56.59	15.58	7.4	13.03	5	3	11	Blade
N104 E48	11	31	Complete	34.21	83.54	28.64	0	26.76	14.34	5	11	Blade
N104 E48	10	?	Complete	11.98	73.78	24.91	0	3.84	2.64	4	12	Blade
N104 E48	11	67	Complete	3.52	58.11	19.24	6.19	12.87	3.81	3	12	Blade
N104 E50	10	3	Complete	8.8	66.2	28.11	3.957	NA	NA	2	8	Blade
N114 E50	10	16	Complete		42.96	19.71	6.23	8.77	3.6	2	7	Blade
N114 E50	7	2	Complete	3.8	51.19	14.74	4.53	5.93	4.23	2	11	Blade
N138 E36	5	31	Complete	5.3	62.2	13.35	3.53	NA	NA	2	8	Blade
N138 E36	6	17	Complete	4.3	44.38	23.39	5.15	5.88	4.19	4	9	Blade
N138 E36	7	37	Complete	7.8	51.33	27.47	0	15	5.58	5	11	Blade
N138 E36	5	19	Complete	8.9	64.63	22.36	7.87	8.33	2.45	2	11	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N144 E42	10	11	Complete	4.69	55.77	15.59	4.55	NA	NA	3	8	Blade
N148 E48	10	10	Complete	13.85	57.9	23.21	0	NA	NA	1	7	Blade
N152 E50	10	11	Complete	52.2	69.43	37.21	0	32.05	11.24	7	8	Blade
N158 E56	TT	63	Complete	2.8	47.1	12.47	0	5.18	1.89	2	11	Blade
N158 E56	TT	59	Complete	10.5	45.25	26.96	0	5.71	3.69	2	12	Blade
N160 E56	TT	4	Complete	23.8	67.5	36.82	0	21.34	7.82	2	9	Blade
N170 E62	10	123	Complete	9.9	33.23	35.88	0	9.01	2.98	3	7	Blade
N170 E62	9	135	Complete	27.05	80.88	34.48	0	NA	NA	2	8	Blade
N170 E62	9	112	Complete	14.49	60.47	26.8	8.45	NA	NA	2	9	Blade
N170 E62	10	106	Complete	18.25	64.04	31.56	0	28.83	12.6	2	11	Blade
N170 E62	9	179	Complete	34.68	97.73	31.08	6.74	10.3	3.5	5	12	Blade
N172 E62	10	34	Complete	10.73	50.05	26.32	0	4.33	2.75	2	7	Blade
N172 E62	10	80	Complete	6.5	60.62	19.43	0	5.24	2.61	1	8	Blade
N172 E62	10	70	Complete	22.4	64.2	25.44	0	15.07	9.94	2	8	Blade
N172 E62	11	6	Complete	11.8	63.17	26.35	0	NA	NA	1	9	Blade
N172 E62	9	25	Complete	3.6	59.47	17.44	5.36	3.4	3.17	3	10	Blade
N234 E106	8		Complete	28.8	92.95	24.29	6.94	13.58	3.96	8	11	Blade
N238 E134	3	01-134	Complete	3.49	55.83	18.32	4.78	10.87	3.5	2	7	Blade
N238 E134	3	01-131	Complete	7.56	54.74	21.86	4.14	5.3	3.89	3	9	Blade
N242 E128	8	7	Complete	1.42	43.17	12.58	0	2.9	1.77	4	11	Blade
N246 E142	4	5	Complete	2.89	51.31	13.41	4.63	5.95	3.14	3	11	Blade
N284 E134	9	23	Complete	0.7	18.47	12.71	0	4.6	1.13	2	8	Blade
N284 E134	11	B	Complete	8.9	60.74	21.92	4.6	11.94	5.95	5	9	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N284 E134	9	14	Complete	3.4	46.5	23.63	9.56	10.79	6.73	2	10	Blade
N284 E134	10	35	Complete	0.05	12.09	6.07	0	4.31	1.7	3	11	Blade
N286 E 136	10	29	Complete	2.2	39.57	16.03	0	8.48	3.55	1	9	Blade
N286 E 136	10	32	Complete	2.6	34.22	15	0	7.9	4.06	2	11	Blade
N286 E 138	12	A	Complete		32.85	15.34	3.4	8.36	4.07	3	11	Blade
N286 E132	11	1	Complete	7.83	63.06	31.02	8.64	11.14	2.99	4	9	Blade
N286 E134	9	37	Complete	1.15	37.8	12.52	0	NA	NA	2	8	Blade
N286 E134	10	1	Complete	2.73	41.08	15.53	0	7.66	3.72	2	9	Blade
N286 E134	9	34	Complete	1.42	34.22	13.52	0	6.49	2.82	2	11	Blade
N286 E134	8	A	Complete	3.95	44.78	15.67	6.16	8.73	3.32	2	12	Blade
N286 E134	8	B	Complete	1.95	46.02	16.97	0	NA	NA	2	7	Blade
N286 E134	9	36	Complete	2.89	37.37	18.24	5.72	NA	NA	2	8	Blade
N286 E134	12	2	Complete		36.77	15.89	0	6.58	2.33	4	9	Blade
N286 E134	9	33	Complete	3.74	46.7	19.82	6.4	14.34	4.64	2	9	Blade
N286 E134	9	26	Complete	5.1	46.46	15.36	0	8.22	3.71	2	10	Blade
N286 E136	10	27	Complete	2.7	53.89	15.71	7.25	7.91	2.74	2	9	Blade
N286 E136	10	68	Complete	2.76	41.59	18.91	0	11.59	4.14	3	9	Blade
N286 E138	10	2	Complete	3.1	64.64	19.61	0	NA	NA	2	9	Blade
N286 E138	12	A	Complete	24.9	75.82	42.39	0	24.85	16.33	3	9	Blade
N286 E138	12	1	Complete		80.31	23.35	1.33	9.59	4.99	2	12	Blade
N286 E138	12	F	Complete	12.5	73.24	30.55	9.58	NA	NA	4	7	blade
N286 E138	12	C	Complete	18.7	80.63	31.87	2.46	NA	NA	2	8	Blade
N286 E138	13	B	Complete	1.7	34.87	20.08	NA	6.07	1.79	5	10	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N286 E138	12	E	Complete	13.5	74.24	33.43	4.64	13.43	4.49	2	11	Blade
N286 E138	12	J	Complete	9.4	61.24	20.36	3.6	7.15	3.39	3	11	Blade
N286 E138	12	G	Complete		68.87	26.16	0	16.17	14.1	1	12	blade
N288 E136	7	1	Complete	118.6	143.9	47.66	0	19	11.5	2	11	Blade
N290 E132	12	2	Complete	7.65	42.2	28.03	8.11	9.95	11.13	5	9	Blade
N290 E132	10	4	Complete	4.45	61.89	18.53	4.42	14.43	3.58	2	10	Blade
N76 E182			Complete		62.88	20.44	0	16.32	15.02	2	7	Blade
TU 04	4		Complete	45.1	81.81	47.56	2.11	32.8	19.73	2	7	Blade
TU 04	4		Complete	17	75.93	38.46	10.29	25.63	7.27	7	8	Blade
TU 04	4	18	Complete	6.2	43.5	18.18	0	8.73	5.61	2	11	Blade
TU 04	5	3	Complete	8.6	46.45	20.82	7.9	6.44	3.04	2	11	Blade
TU 04	2	31	Complete	4	47.05	15.69	0	8.58	6.4	5	11	Blade
TU 04			Complete	12.6	68.91	28.11	9.44	22.86	7.96	5	7	Blade
TU 04	1	9	Complete	38	92.71	37.71	2.83	10.5	7.88	4	8	Blade
TU 04	2	33	Complete	2.1	39.02	11.2	0	NA	NA	3	9	Blade
TU 04	2	26	Complete	6.5	43.63	20.55	3.64	16.79	5.66	6	10	Blade
TU 04	4	2	Complete	28.6	75.05	32.63	NA	9.14	5.82	4	11	Blade
TU 04	4	22	Complete	7.2	57.13	16.31	0	10.06	3.64	2	11	Blade
TU 04	2	14	Complete	1.9	34.77	12.87	5.17	3.3	1.75	2	11	Blade
TU 10	2	21	Complete	7	52.25	19.33	0	12.29	6.48	6	11	Blade
TU 10	2	18	Complete	15.17	62.84	20.53	0	14.89	11.1	2	11	Blade
TU 11	2	2	Complete	34.53	76.37	37.59	6.93	NA	NA	11	8	Blade
TU 11	2	1	Complete	31.05	99.84	41.43	2.72	9.55	3.24	4	10	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
TU 11	2	13	Complete	2.47	37.64	15.08	8.04	11	4.43	3	10	Blade
TU 11	2	11	Complete	10.63	73.11	21.06	6.37	4.54	2.96	4	12	Blade
TU 11	2	9	Complete	9.74	83.55	20.2	5.52	12.85	4.76	3	11	Blade
TU 5	4	A	Complete		63.11	20.2	5.45	10.9	6.77	1	9	Blade
TU 5	3	C	Complete	2.5	46.41	13.4	9.76	NA	NA	4	8	Blade
TU 5	3	F	Complete	3.1	37.9	12.48	0	9.63	6.96	2	9	Blade
TU 5	4	2	Complete		104.33	37.19	4.31	26.85	7.05	8	9	Blade
TU 5	4	4	Complete	39.9	142.85	34.35	6.49	6.4	4.04	10	11	Blade
TU 5	3	A	Complete	2	34.63	13.81	7.39	6.42	4.11	2	11	Blade
TU 6	4	3	Complete	9.8	53.36	21.51	0	18.92	12.17	2	8	Blade
TU 6	3	B	Complete	5.2	38.44	16.09	0	6.45	7.27	2	11	Blade
TU 6	3	D	Complete	2	30.36	12	0	8.92	2.92	2	12	Blade
TU 7	5	20	Complete	3.13	43.94	20.7	0	4.58	2.86	4	10	Blade
TU 7	6	3	Complete	1.54	38.73	12.24	2.58	3.74	2.54	2	11	Blade
TU 7	3	F	Complete	5	42.51	21.08	0	15.15	7.41	2	11	Blade
TU 7	4	F	Complete	2.3	33.33	15.03	5.49	14.49	7.23	2	11	Blade
TU 7	3	2	Complete	2.3	41.9	13.89	0	6.58	3.6	2	12	Blade
TU 9	2	5	Complete	3.8	45.87	12.84	10.68	2.99	1.83	6	7	Blade
TU 9	2	A	Complete	2.3	40.74	14.15	0	11.23	4	4	9	Blade
TU 9	2	G	Complete	2.2	53.78	10.77	2.39	4.83	1.89	4	9	Blade
N240 E128	5	01-162	Complete	1.54	54.42	10.45	0	3.52	1.57	4	11	Blade
N244 E136	6	1	Medial	0.94	23.97	9.51	0	NA	NA	1	8	Blade
N160 E56	TT	51	Medial	13.4	38.35	31.85	NA	NA	NA	3	8	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N104 E50	10	20	Complete	31.9	71	29.63	4.04	17.63	10.75	2	12	Blade, corner
TU 04	2	22	Complete	23.2	67.85	38.59	0	15.74	11.54	2	10	Blade, corner
TU 04	4	25	Complete	11	55.04	30	7.08	13.1	5.86	2	12	Blade, corner
TU 5	3	D	Complete	2.8	38.91	11.9	5.37	10.82	6	2	11	Blade, corner
TU 5	5	2	Complete	7.8	45.38	19.75	0	21.44	10.09	2	11	Blade, corner
TU 7	4	C	Complete	3.7	42.47	16.56	NA	NA	NA	2	8	Blade, corner
TU 7	5	A	Complete		51.27	23.6	0	12.71	5.57	2	10	Blade, corner
N122 E64	9	104	Complete	28.35	95.22	28.4	12.39	NA	NA	3	8	Blade, Crest
N138 E36	8	1	Complete	93.2	114.87	36.02	14.45	19.97	5.28	2	9	Blade, crest
N152 E50	10	12	Complete	22.2	73.18	33.67	11.43	6.98	3.22	2	11	Blade, crest
N170 E62	9	96	Complete	11.46	52.08	22.42	10.86	17.28	13.05	2	11	Blade, crest
N172 E62	10	63	Complete	63.75	100.1	40.21	7.86	26.2	15	3	8	Blade, crest
Roadbed			Complete	51.3	83.82	34.19	0	19.12	21.05	2	9	Blade, crest
Roadbed			Complete		91.61	24.17	9.24	6.84	6.85		9	Blade, crest
TU 04	5	2	Complete	4.9	55.85	18.82	6.1	8.96	4.56	2	11	Blade, crest
TU 6	3	6	Complete	31.5	75.31	33	3.76	14.09	5.9	2	7	Blade, crest
TU 6	4	1	Complete	11.6	63.34	27.51	6.17	9.03	4.09	2	10	Blade, crest
TU 8	6	8	Complete	16.4	83.76	21.16	2.99	NA	NA	2	8	Blade, crest
N144 E42	10	57	Distal	6.99	41.39	29.88	3.43	NA	NA	2	9	Blade
N144 E42	10	Screen	Distal	3.3	58.2	17.22	0	7.6	3.33	2	10	Blade
N148 E48	9	35	Distal	9.54	38.14	30.22	0	NA	NA	2	8	Blade
N242 E128	9	12	Distal	1.71	26.94	17.94	0	NA	NA	3	8	Blade
N242 E128	9	10	Distal	8.59	44.01	23.06	0	NA	NA	2	8	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Lev-el	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N244 E136	6	2	Distal	1.59	42.25	15.16	0	NA	NA	2	8	Blade
N284 E134	11	A	Distal	1.5	37.43	11.19	0	NA	NA	2	8	Blade
N284 E134	10	34	Distal	1.3	35.98	15.5	3.83	NA	NA	2	8	Blade
N286 E134	9	39	Distal	1.11	30.57	12.59	0	2.16	1.08	2	8	Blade
N286 E138	12	B	Distal	3.1	26.14	27.91	NA	NA	NA	2	8	Blade
TU 04	4	5	Distal	4.1	32.46	24.97	0	NA	NA	2	8	Blade
TU 04	2	28	Distal	1.3	28.51	13.57	0	NA	NA	2	8	Blade
TU 10	2	27	Distal	7.74	41.7	28.96	0	NA	NA	2	8	Blade
TU 5	3	H	Distal	1.4	31.81	13.22	0	NA	NA	2	8	Blade
TU 7	3	B	Distal	3.9	39.01	18.42	NA	NA	NA	2	8	Blade
TU 8	5	4	Distal	10.4	71.46	29.58	3.2	NA	NA	2	8	Blade
N104 E48	11	37	Medial	1.59	21.86	17.3	0	NA	NA	2	8	Blade
N104 E50	9	5	Medial	44.93	75.48	41.12	5.8	NA	NA	2	8	Blade
N104 E50	10	21	Medial	10.4	35.87	29.69	0	NA	NA	2	9	Blade
N148 E48	9	18	Medial	13.08	47.7	30.66	7.29	NA	NA	2	8	Blade
N150 E 50	10	8	Medial		44.82	30.71	2.53	NA	NA		8	Blade
N150 E150	10	8	Medial		37.15	30.83	NA	NA	NA	2	8	Blade
N158 E56	TT	71	Medial	9.1	35.82	29.04	5.3	NA	NA	2	8	Blade
N158 E56	TT	50	Medial	13	50.91	27.91	7.54	NA	NA	2	9	Blade
N158 E56	TT	12	Medial	12.7	40.97	27.02	0	NA	NA	2	9	Blade
N160 E56	TT	49	Medial	4	57.13	14.78	3.79	NA	NA	2	8	Blade
N170 E62	9	34	Medial	21.84	61.79	47.61	0	NA	NA	2	8	Blade
N170 E62	9	47	Medial	3.7	30.08	20.38	0	NA	NA	2	8	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N242 E128	9	3	Medial	6.71	32.11	29.67	0	NA	NA	3	8	Blade
N242 E128	9	9	Medial	2.98	25.68	23.58	0	NA	NA	3	8	Blade
N276 E152	4	2	Medial	7.6	30.14	39.99	0	NA	NA	2	8	Blade
N284 E134	10	32	Medial	0.46	16.97	14.22	NA	NA	NA	6	8	Blade
N284 E134	10	52	Medial	0.2	6.32	20.49	0	NA	NA	2	8	Blade
N284 E134	9	26	Medial	0.3	15.04	11.24	0	NA	NA	4	8	Blade
N286 E134	7	A	Medial	12.83	60.85	24.62	4.66	NA	NA	4	8	Blade
N286 E134	9	13	Medial	2.14	22.59	24.62	NA	NA	NA	2	8	Blade
N286 E138	12	D	Medial	11	59.45	29.82	7.7	NA	NA	3	8	Blade
N286 E138	9	B	Medial	1.6	34.42	16.11	NA	NA	NA	4	8	Blade
N286 E138	9	C	Medial	1.3	23.43	21.17	NA	NA	NA	3	8	Blade
N286 E138	13	D	Medial	10.1	21	47.43	NA	NA	NA	3	8	Blade
N288 E136	12	5	Medial	9.3	41.12	19.01	0	NA	NA	4	8	Blade
Roadbed			Medial		32.13	29.72	0	NA	NA		8	Blade
TU 04	4	11	Medial	4.7	17.97	39.05	0	NA	NA	2	8	Blade
TU 04	4	14	Medial	2.9	20.93	28.1	NA	NA	NA	3	9	Blade
TU 04	4		Medial	5.5	32.59	33.28	NA	NA	NA	3	9	Blade
TU 10	2	31	Medial	4.8	44.16	21.2	0	17.14	4.32	5	8	Blade
TU 6	5	B	Medial	3.6	27.97	21.09	NA	NA	NA	2	8	Blade
TU 6	3	C	Medial	1.5	27.12	16.09	0	NA	NA	4	8	Blade
TU 7	4	B	Medial	1.6	24.1	20.84	NA	NA	NA	3	8	Blade
TU 7	4	D	Medial	5.5	26.21	33.82	NA	NA	NA	3	8	Blade
TU 7	4	J	Medial	0.8	24.69	12.66	NA	NA	NA	4	8	Blade
TU 7	6	A	Medial	0.62	21.18	14.35	NA	NA	NA	2	8	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Levl	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
TU 7	6	F	Medial	0.69	10.42	19.22	NA	NA	NA	3	8	Blade
TU 7	6	G	Medial	1.65	14.4	19.61	NA	NA	NA	2	8	Blade
TU 9	2	B	Medial	0.5	13.89	14.51	0	NA	NA	2	8	Blade
N100 E40	7	6	Proximal	13.1	44.76	27.85	5.16	5.54	2.86	5	11	Blade
N100 E62	8	5	Proximal	37.15	68.86	51.5	2.99	13.53	3.41	2	9	Blade
N102 E64	6	13	Proximal	15.97	48.26	35.33	0	18.7	8.25	3	11	Blade
N122 E64	8	122	Proximal	5.3	25.61	28.74	0	9.84	5.73	5	10	Blade
N138 E36	7	33	Proximal	38.5	64.34	53.62	0	12.56	9.02	4	9	Blade
N138 E36	5	1	Proximal	13.7	43.79	34.23	0	8.86	3.1	2	10	Blade
N138 E36	8	16	Proximal	16.6	56.46	25.42	0	8.57	7.82	2	11	Blade
N138 E36	6	29	Proximal	22.6	57.27	38.26	0	11.69	6.02	6	11	Blade
N144 E42	11	12	Proximal		34.72	41.24	0	25.92	8.73	3	11	Blade
N144 E42	10	7	Proximal	4.45	28.62	26.3	0	12.1	3.37	2	11	Blade
N148 E48	10	11	Proximal	8.74	33.03	36.03	0	12.9	8.21	3	11	Blade
N160 E56	TT	53	Proximal	8.4	38.87	24.27	0	13.61	11.94	2	11	Blade
N170 E 62	10	15	Proximal	11.1	44.28	37.21	NA	10.48	4.07	4	9	Blade
N170 E62	9	98	Proximal	6.01	46.45	28.33	0	6.95	NA	2	10	Blade
N170 E62	9	62	Proximal	7.22	37.88	23.5	0	18.23	9.11	2	11	Blade
N170 E62	9	41	Proximal	10.39	34.13	28.24	0	15.9	8.73	3	11	Blade
N170 E62	10	52	Proximal	20.11	40.62	37.48	0	15.92	7.4	4	11	Blade
N242 E128	9	8	Proximal		24.64	29.21	0	7.41	5.51	2	11	Blade
N244 E128	9	1	Proximal	0.91	35.58	8.9	6.85	3.62	2.23	2	12	Blade
N284 E 136	10	13	Proximal	25.51	46.21	36.25	0	19.82	14.03	7	8	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N284 E134	10	12	Proximal	4.84	41.87	31.32	4.65	5.65	2.48	6	9	Blade
N284 E134	10	?	Proximal		62.89	31.89	NA	5.51	2.88	5	9	Blade
N286 E134	9	13	Proximal	2.12	34.72	11.31	NA	NA	NA	4	8	Blade
N286 E134	7	B	Proximal	1.34	34.53	12.75	8.22	7.3	2.09	6	10	Blade
N286 E134	9	32	Proximal	1.54	19.36	21.22	NA	13.38	4.07	2	11	Blade
N286 E138	12	B	Proximal	14.7	53.07	34.33	0	20.63	6.33	6	11	Blade
N286 E138	13	1	Proximal	20.9	52.7	47.1	NA	15.62	5.39	2	11	Blade
N286 E138	14	8	Proximal	23.3	81.12	33.06	6.57	6.21	3.6	4	11	Blade
N286 E138	12	I	Proximal	4.4	28.91	23.61	0	NA	NA	2	11	Blade
N286 E138	14	A	Proximal	3.4	22.42	31.19	NA	13.97	4.25	2	11	Blade
Roadbed		16	Proximal	13.25	37.46	35.52	0	8.9	2.71	4	11	Blade
TU 04	5	7	Proximal	4.8	29.04	28.71	0	6.56	3.53	2	11	Blade
TU 04	4	9	Proximal	5.7	36.26	26.13	0	6.61	3.67	3	9	Blade
TU 04	5	6	Proximal	10.4	40.36	32.63	0	14.29	4.66	4	11	Blade
TU 04	4		Proximal		27.83	20.9	0	14.66	6.16	2	11	Blade
TU 04	4		Proximal		38.11	26.68	NA	NA	NA		11	Blade
TU 10	2	14	Proximal	2.24	25.56	24.94	0	10.14	3.36	2	7	Blade
TU 10	2	25	Proximal	8.4	41.87	30.48	4.7	6.45	6.18	1	11	Blade
TU 11	2	16	Proximal	8.55	39.26	34.17	0	9.26	2.95	5	9	Blade
TU 11	2	1	Proximal	31.1	98.23	36.9	3.28	8.84	3.18	3	9	Blade
TU 11	2	4	Proximal	4.02	28.52	16.24	0	4.28	2.57	4	8	Blade
TU 5	4	3	Proximal	5.4	22.87	36.11	0	11.47	6.28	4	9	Blade
TU 5	3	B	Proximal	6.5	42.26	20.73	10.45	11.21	4.15	5	8	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
TU 6	3	1		5.2	36.18	23.89	0	8.58	3.69	3	9	Blade
TU 6	5	A		1.2	14.63	17.45	NA	9.63	3.06	3	11	Blade
TU 6	5	C		2.5	21.41	22.98	NA	6.12	2.33	2	11	Blade
TU 7	6	1		2	33.48	22.14	0	4.84	2.22	2	9	Blade
TU 7	4	2		2.9	28.76	17.62	0	10.35	3.49	2	9	Blade
TU 7	4	H		1.6	26.91	17.34	NA	9.04	2.64	3	9	Blade
TU 7	6	2		1.83	30.07	18.81	5.53	NA	NA	3	10	Blade
TU 7	5	16		6.36	25.34	31.77	0	9.63	2.63	8	8	Blade
TU 7	4	E		1.2	23.1	20.48	NA	7	2.85	2	9	Blade
TU 7	6	E		0.81	22.25	12.62	NA	9.02	4.3	2	9	Blade
TU 7	4	I		1.6	14.98	20.82	NA	6.44	2.77	2	11	Blade
TU 7	6	B		0.97	16.69	14.83	NA	6.58	3.95	2	11	Blade
TU 9	2	16		36.08	91.14	39.77	5.23	23.46	6.45	3	9	Blade
TU 9	2	15		3	28.62	15.46	0	10.85	6.3	3	11	Blade
TU 9	2	C		0.7	14.78	17.03	0	4.05	1.76	2	11	Blade
TU 9	2	F		3.2	33.79	17.69	0	8.58	2.3	3	11	Blade
TU 9	2	6		5.3	36.71	25.37	0	10.26	5.25	5	9	Blade
N150 E 50	10	10		3.7	41.38	24.77	0	4.88	1.81	3	9	Blade
N104 E48		1			139.52	58.05	7.97	16.48	6.27	9	11	Blade
N284 E134	9	21		75.2	111.75	41.13	8.02	NA	NA	4	8	Blade
N286 E134	9	4		21.35	66.54	33.26	0	NA	NA	1	9	Blade
TU 10	2	22		65.8	77.36	47.05	4.86	22.69	20	10	9	Blade
TU 5	3	E		5.7	58.16	19.17	0	9.64	6.71	2	11	Blade

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
TU 7	4	A	Complete	1.9	31.42	14.26	6.52	11.76	3.94	2	9	Blade
TU 8	5	2	Complete	14.1	66.42	24.98	9.22	NA	NA	3	9	Blade
N122 E64	8	103	Complete	81.2	112.39	37.33	7.26	26.78	15.54	1	9	Blade
N284 E134	9	29	Complete	0.9	27.65	11.09	0	14.21	5.82	2	3	BLF
N104 E48	11	19	Complete	10.19	53.48	28.05	13.16	11.76	11.68	4	6	BLF
N1152 E50			Complete		72.98	32.49	9.56	6.06	3.35	0	3	BLF
N138 E36	8	3	Complete	25.2	79.88	36.32	0	NA	NA	3	3	BLF
N138 E36	7	27	Complete	35.4	82.35	39.36	5.59	NA	NA	2	3	BLF
N144 E42	10	24	Complete	8.45	56.31	26.09	2.58	NA	NA	4	6	BLF
N144 E42	11	43	Complete	23.12	77.12	36.16	7.78	14.46	8.93	6	6	BLF
N148 E48	9	15	Complete	3.95	57.47	25.44	4.8	5.33	1.94	4	4	BLF
N148 E48	9	8	Complete	6.8	45.16	24.05	0	9.14	3.85	5	6	BLF
N150 E50	10	1	Complete	6.6	52.03	26.13	12.27	14.92	5.65	4	1	BLF
N150E50	10	4	Complete	7	64.86	21.21	4.68	NA	NA	7	0	BLF
N152 E50			Complete		49.77	24.26	0	25.35	7.77		3	BLF
N152 E50	10	5	Complete	13.8	50.08	30.42	NA	24.16	8.75	4	6	BLF
N158 E56			Complete		69.34	28.88	2.07	12.59	28.88		4	BLF
N158 E56	TT	9	Complete	38.2	65.87	26.3	0	25.32	12.69	5	6	BLF
N170 E 62	10	8	Complete	3	42.77	17.71	5.63	NA	NA	5	5	BLF
N170 E62	10	107	Complete	1.51	48.15	10.91	0	NA	NA	2	5	BLF
N170 E62	9	113	Complete	9	68.55	23.12	5.57	NA	NA	1	6	BLF
N170 E62	9	175	Complete	14.69	78.87	36.42	6.87	16.02	5.1	5	6	BLF
N172 E62	9	15	Complete	11.6	79.02	31.31	4.41	9.67	3	5	5	BLF

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N242 E128	8	1	Complete	3.04	57.57	20	6.87	6.88	3.02	4	6	BLF
N284 E134	9	17	Complete	0.8	30.13	14.19	0	2.91	1.85	3	6	BLF
N284 E134	10	14	Complete	23.46	69.81	35.22	0	22.15	12.64	8	1	BLF
N284 E134	10	8	Complete	8.69	62.56	27.55	11.02	16.57	4.62	4	4	BLF
N284 E134	10	19	Complete	5.01	48.26	20.08	0	6.66	2.95	2	6	BLF
N284 E134	9	16	Complete	3.3	43.46	21.8	3.79	13.5	5.5	2	6	BLF
N286 E134	10	27	Complete	4.3	42.44	25.14	NA	NA	NA	3	4	BLF
N286 E134	9	12	Complete	6.13	40.58	20.1	5.19	NA	NA	2	4	BLF
N286 E136	10	41	Complete	2.1	44.31	13.46	7.47	NA	NA	4	3	BLF
N286 E136	10	69	Complete	1.8	43.42	14.86	0	NA	NA	2	6	BLF
N286 E138	9	A	Complete	1	33.61	11.87	0	2.88	1.86	2	4	BLF
N286 E138	12	H	Complete	3.1	52.86	18.53	7.25	3.9	1.64	4	5	BLF
N286 E138	13	C	Complete	4.2	41.55	18.15	0	15.15	6.6	2	6	BLF
TU 11	2	17	Complete	39.58	84.75	50.93	13.5	22.54	10.53	7	6	BLF
TU 7	4	4	Complete	6.7	63.01	24.64	7.34	5.48	2.34	6	5	BLF
TU 7	3	D	Complete	7.9	57.3	26.34	5.81	13.84	6.33	5	3	BLF
TU 7	3	E	Complete	2.7	39.85	18.9	5.47	6.26	3.49	4	3	BLF
TU 7	3	C	Complete	2.5	47.34	14.71	1.68	4.12	2.04	4	6	BLF
TU 9	2	E	Complete	1.4	33.8	22.16	4.61	NA	NA	4	3	BLF
TU 9	2	D	Complete	5.6	47.09	21.34	6.32	19.33	9.09	4	6	BLF
TU 6	3	A	Complete	7.9	42.8	24.03	8.73	11.78	5.32	0	6	BLF, Corner
N144 E42	11	2	Complete	19.34	73.12	30.71	10.16	9.2	8.32	5	6	BLF Crest
N150 E50	10	9	Complete	29.4	85.69	40.49	9.24	NA	NA	8	2	BLF Crest

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Level	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N284 E134	10	26	Complete	18.94	62.03	31.53	10.05	19.17	10.14	6	6	BLF Crest
TU 7	3	3	Complete	20.4	76.79	31.1	10.19	5.58	2.91	13	6	BLF Crest
N286 E136	10	6	Complete	8.52	62.16	22.15	3.33	18.22	3.86	6	3	BLF Crest
N100 E38	7	9	Distal	36.45	82.17	27.75	2.53	NA	NA	5	6	BLF
N104 E50	10	2	Distal	4	51.79	20.69	0	NA	NA	2	6	BLF
N158 E56	TT	57	Distal	13.6	61.63	18.02	0	NA	NA	3	3	BLF
N172 E62	10	2	Distal	5.2	48.34	25.2	6.68	NA	NA	5	0	BLF
N234 E106			Distal		80.54	21.62	11.54	NA	NA	9	5	BLF
N242 E128	9	13	Distal	3.26	37.81	31.91	3.43	NA	NA	2	6	BLF
N284 E134	9	20	Distal	2.3	31.83	16.13	0	NA	NA	2	3	BLF
N286 E138	13	A	Distal	3	28.49	31.61	NA	NA	NA	4	6	BLF
N286 E138	12	C	Distal	1.5	30	22.01	NA	NA	NA	2	6	BLF
TU 04	2	7	Distal		24.27	13.75	0	NA	NA	2	3	BLF
TU 10	2	26	Distal	6.8	61.47	25.79	0	NA	NA	6	5	BLF
TU 10	2	23	Distal	3.5	34.33	26.46	6.4	NA	NA	3	6	BLF
TU 5	3	G	Distal	2.2	33.12	13.61	2.77	NA	NA	3	6	BLF
TU 7	3	A	Distal	2.3	40.66	17.79	2.53	NA	NA	2	6	BLF
TU 7	6	D	Distal	1.33	21.12	19.99	NA	NA	NA	4	6	BLF
N160 E56	TT	45	Medial	9	65.14	22.69	10.02	NA	NA	8	3	BLF
N172 E62	10	52	Medial	2.46	42.28	19.43	7.61	NA	NA	4	5	BLF
N172 E62	10	16	Medial	3.76	56.25	21.75	4.72	NA	NA	2	5	BLF
N284 E134	9	34	Medial	0.7	8.03	23.36	0	NA	NA	3	5	BLF
N284 E134	9	7	Medial	0.6	19.46	11.15	0	NA	NA	1	6	BLF

Appendix II. Morphological Attributes of Blades

Provenience			Portion	Morphological Attributes								Interpretation
Unit	Lev-el	Art#		Weight	L (max)	W (max)	I/C	P/W	P/Th	Scars	AV	
N286 E136	10	28	Medial	8.5	32.76	31.95	0	NA	NA	3	5	BLF
Roadbed		5	Medial	47.2	72.87	46.57	0	NA	NA	8	5	BLF
TU 6	3	E	Medial	0.7	21.41	15.19	0	NA	NA	2	6	BLF
TU 7	6	C	Medial	2.5	21.99	27.43	NA	NA	NA	3	3	BLF
TU 7	6	H	Medial	0.71	13.09	16.96	NA	NA	NA	2	5	BLF
TU 7	4	G	Medial	0.9	20.05	18.68	NA	NA	NA	3	6	BLF
N138 E36			Proximal		51.11	26	0	14.88	6.03		4	BLF
N138 E36	5	3	Proximal	2	35.41	14.82	3.19	6.82	2.58	3	6	BLF
TU 7	6	4	Proximal	1.66	29.61	20.36	0	4.85	2.94	1	5	BLF
TU 7	5	19	Proximal	2.62	24.78	33.96	0	6.67	2.95	3	6	BLF

Appendix III.

Technological Attributes of Cores

Appendix III. Technological Attributes of Cores

Provenience			Portion	Technological Attributes							Interpretation	
Unit	Lvl.	Art.		Scars	Con. scars	Failed term.	Platforms	Platform	Prep.	Direc.		
N114 E50	10	25	Complete	19	3	7	1	Faceted	Present	Uni	Blade Core	Cylindrical
TU 8	6	1	Complete	14	4	6	1	Multi-Faceted	Present	Uni	Blade Core	Conical
N122 E064	8	28	Complete	16	7	5	1	Plain	Present	Uni	Blade Core	Conical
N144 E42	10	64	Complete	9	2	0	2	Plain	Present	Bi	Blade Core	Wedge
N284 E134	11		Fragment	5	NA	0	NA	NA	NA	Bi	Blade Core	Wedge
TU 8	5	1	Fragment	7	2	0	2	Plain	Absent	Bi	Blade Core	Wedge
TU 9	2	8	Complete	20	10	11	3	Plain	Present	Multi	Blade Core	Wedge
N100 E038	7	18	Complete	14	5	6	3	Multi-faceted	Present	Multi	Blade Core	Wedge
N100 E040	6	22	Complete	8	0	5	2	Plain	Present	Bi	Blade Core	Wedge
N102 E066	7	14	Complete	19	1	4	4	Multi-faceted	Present	Multi	Blade Core	Wedge
N102 E50		12	Fragment	6	4	1	1	Plain	Absent	Bi	Blade Core	Wedge
N102 E50		11	Fragment	8	3	3	1	Plain	Absent	Bi	Blade Core	Wedge
N122 E06	8	7	Complete	12	4	2	1	Faceted	Present	Bi	Blade Core	Wedge
N286 E136	12	11	Fragment	13	1	1	2	NA	Absent	Multi	Blade Core	Wedge
TU9	2	10	Fragment	6	3	4	1	Plain	Absent	Bi	Blade Core	Wedge
N144 E42	11	14	Fragment	2	0	0	1	Plain	Absent	Uni	Blade Core	Ind
N144 E42	11	39	Fragment	8	1	3	1	Faceted	Absent	Uni	Blade Core	Ind
N160 E56	TT	28	Fragment	4	3	0	1	Plain	Absent	Bi	Blade Core	Ind
N104 E50	9	11	Fragment	4	0	1	NA	NA	Absent	Bi	Blade Core	Ind
N114 E50	6	2	Fragment	4	1	2	1	Plain	Absent	Uni	Blade Core	Ind
N240 E128	3	4	Fragment	10	2	1	1	Faceted	Present	Uni	Blade Core	Ind
N150 E150	10	50	Fragment	9	1	2	1	Plain	Absent	Uni	Blade Core	Ind

Provenience			Portion	Technological Attributes							Interpretation	
Unit	Lvl.	Art.		Scars	Con. scars	Failed term.	Platforms	Platform	Prep.	Direc.		
N158 E56	TT	1	Fragment	10	2	2	2	Plain	Absent	Bi	Flake Core	Bi
TU 5	3	2	Complete	14	5	10+	2	Multi-Faceted	Present	Bi	Flake Core	Bi
TU 5	4	7	Complete	11	5	4	2	Faceted	Absent	Bi	Flake Core	Bi
N120 E50	10	6	Complete	12	6	3	1	Faceted	Present	Uni	Flake Core	Conical
N144 E42	10	28	Complete	18	4	7	3	Faceted	Present	Multi	Flake Core	Multi
N158 E56	TT	7	Fragment	8	0	1	NA	Plain	Absent	Multi	Flake Core	Multi
N288 E136	12	2	Complete	14	3	1	3	Plain	Absent	Multi	Flake Core	Multi
N158 E56	TT	5	Face	NA	NA	NA	NA	NA	Absent	NA	Flake Core	NA
N104 E48	10	7	Fragment	15	3	3	2	Faceted	Present	Multi	Gen. Core	Amorphous
N104 E50	10	12	Complete	21	5	16	2	Plain	Absent	Multi	Gen. Core	Amorphous
N114 E50	10	26	Complete	17	4	3	1	Multi-Faceted	Present	Multi	Gen. Core	Amorphous
N138 E136	5	4	Fragment	12	NA	2	NA	NA	NA	Multi	Gen. Core	Amorphous
N138 E136	7	7	Fragment	17	5	7	3	Faceted	Present	Multi	Gen. Core	Amorphous
N138 E136	8	17	Fragment	9	NA	2	NA	NA	NA	Multi	Gen. Core	Amorphous
N138 E136	8	6	Fragment	8	1	1	1	Faceted	Present	Multi	Gen. Core	Amorphous
N138 E136	8	29	Complete	10	NA	2	NA	NA	NA	Multi	Gen. Core	Amorphous
N144 E42	10	74	Complete	18	2	10+	1	Faceted	Absent	Multi	Gen. Core	Amorphous
N160 E56	TT	42	Fragment		0	0	NA	NA	Absent	Multi	Gen. Core	Amorphous
N160 E56	TT	40	Fragment	9	1	2	NA	NA	Absent	Multi	Gen. Core	Amorphous
N160 E56	TT	41	Fragment	9	0	1	NA	NA	Absent	Multi	Gen. Core	Amorphous
N172 E062	11	24	Complete	20	10+	10+	Multiple	Faceted	NA	Multi	Gen. Core	Amorphous
N172 E62	11	25	Complete	25	6	10+	3	Faceted	Present	Multi	Gen. Core	Amorphous
N248 E142	11	2	Complete	17	7	4	4	Faceted	Present	Multi	Gen. Core	Amorphous
N284 E134	9	10	Fragment	13	5	5	2	Faceted	Present	Multi	Gen. Core	Amorphous
N284 E134	10	30	Complete	13	4	10+	2	Cortical	Present	Multi	Gen. Core	Amorphous
N284 E134	10	29	Complete	20+	NA	10+	Multiple	Faceted	Present	Multi	Gen. Core	Amorphous

Provenience			Portion	Technological Attributes							Interpretation	
Unit	Lvl.	Art.		Scars	Con. scars	Failed term.	Platforms	Platform	Prep.	Direc.		
N286 E138	12		Complete	14	4	2	1	Plain	Absent	Multi	Gen. Core	Amorphous
TU 4	2	11	Fragment	6	2	2	1	Plain	Absent	Multi	Gen. Core	Amorphous
TU 4	2	1	Complete	13	5	3	3	Faceted	Present	Multi	Gen. Core	Amorphous
TU 5	3	6	Complete	14	4	10+	1	Multi-Faceted	Present	Uni	Gen. Core	Amorphous
TU 5	3	8	Fragment	12	3	4	3	Faceted	Present	Multi	Gen. Core	Amorphous
TU 5	5	1	Complete	15	4	10+	1	Plain	Absent	Multi	Gen. Core	Amorphous
TU 8	6	2	Complete	18	7	6	2	NA	Present	Multi	Gen. Core	Amorphous
N104 E48	8	39	Complete	11	2	5	2	Plain	Present	Bi	Gen. Core	Bi
N122 E64	8	14	Complete	14	5	2	1	Faceted	Present	Uni	Gen. Core	Conical
N144 E42	11	31	Fragment	3	NA	0	NA	NA	Absent	Bi	Gen. Core	Ind
N160 E56	TT	46	Fragment	9	0	0	NA	NA	Absent	Multi	Gen. Core	Ind
N114 E50	11	2	Complete	14	9	8	4	Plain	Present	Multi	Gen. Core	Multi
N122 E064	8	37	Complete	21	9	5	3	Multi-Faceted	Present	Multi	Gen. Core	Multi
N122 E064	8	29	Complete	19	4	9	1	Plain	Present	Multi	Gen. Core	Multi
N144 E42	11	18	Fragment	5	3	3	3	Plain	Absent	Multi	Gen. Core	Multi
N172 E062	9	2	Fragment	4	1	0	2	Plain	Absent	Multi	Gen. Core	Multi
N284 E134	11		Complete	12	8	4	4	NA	Absent	Multi	Gen. Core	Multi
N284 E136	10	26	Fragment	13	4	10+	2	Faceted	Absent	Multi	Gen. Core	Multi
N284 E136	10	2	Complete	25	8	10	3	Faceted	Present	Multi	Gen. Core	Multi
N286 E136	10		Fragment	15	6	9	3	Plain	Absent	Multi	Gen. Core	Multi
N158 E56	TT	40	Complete	12	6	12	2	Faceted	Absent	Multi	Gen. Core	Amorphous
N286 E134	9	6	Fragment	10	NA	3	NA	NA	NA	Multi	Gen. Core	Amorphous
N286 E134	9	5	Complete	18	5	7	3	Faceted	Absent	Multi	Gen. Core	Amorphous
TU 6	5	7	Fragment	10	NA	5	NA	NA	Absent	Multi	Gen. Core	Amorphous
N172 E062	9	5	Fragment	13	8	1	2	Multi-Faceted	Present	Bi	Gen. Core	Bi
N144 E42	11	8	Fragment	7	NA	0	NA	NA	NA	Multi	Gen. Core	Ind

Provenience			Portion	Technological Attributes							Interpretation	
Unit	Lvl.	Art.		Scars	Con. scars	Failed term.	Platforms	Platform	Prep.	Direc.		
N144 E42	10	65	Fragment	5	0	1	NA	NA	NA	Bi	Gen. Core	Ind
N170 E62	10	101	Fragment	9	NA	0	NA	NA	NA	Multi	Gen. Core	Ind
N114 E50	10	42	Complete	14	2	8	3	Multi-Faceted	Present	Multi	Gen. Core	Multi
N114 E50	10	19	Complete	15	5	9	3	Multi-Faceted	Present	Multi	Gen. Core	Multi
N150 E50	10	34	Complete	13	1	5	Multiple	Plain	Absent	Multi	Gen. Core	Multi
N152 E50	10	15	Complete	29	3	11	2	Plain	Present	Multi	Gen. Core	Multi
N152 E50	10	6	Complete	12	0	1	3	Plain	Absent	Multi	Gen. Core	Multi
N144 E42	12	4	Fragment	2	NA	0	NA	NA	NA	Uni	Ind	Ind
N170 E62	10	81	Fragment	7	NA	0	NA	NA	NA	Ind	Ind	Ind
TU 7	5	8	Fragment	6	NA	0	NA	NA	NA	Ind	Ind	Ind
N170 E62	10	39	Fragment	13	NA	1	NA	NA	NA	Multi	Ind	Multi
N284 E134	10	10	Fragment	8	0	1	NA	Faceted	Present	Multi	Ind	Multi

Appendix IV.

Morphological Attributes of Cores

Appendix IV. Morphological Attributes of Cores

Morphologic Attributes

Provenience			Portion	Length	Width	Weight	W/RS Ratio	RS length	Angle	Interpretation	
N114 E50	10	25	Complete	41.43	81.8	322.23	16.95	36.05	50-55	Blade Core	Cylindrical
TU 8	6	1	Complete	56	74.76	189.08	13.557	46.76	65-70	Blade Core	Conical
N122 E064	8	28	Complete	37.36	90.07	207.32	10.36	57.05	55-60	Blade Core	Conical
N144 E42	10	64	Complete	39.55	54.18	9.13	9.13	42.93	66,76	Blade Core	Wedge
N284 E134	11		Fragment	53.84	54.17	19.275	19.275	54.03	NA	Blade Core	Wedge
TU 8	5	1	Fragment	89.97	98.29	33.1	33.1	67.69	65	Blade Core	Wedge
TU 9	2	8	Complete	53.85	104.71	9.2245	9.2245	48.72	76	Blade Core	Wedge
N100 E038	7	18	Complete	105.76	111.61	914	65.3	94.95	65	Blade Core	Wedge
N100 E040	6	22	Complete	123.42	59.4	413	51.6	97.99		Blade Core	Wedge
N102 E066	7	14	Complete	102.89	67.84	638	35.6	93.3		Blade Core	Wedge
N102 E50		12	Fragment	82.63	43.24	16.85	16.85	55.57	56	Blade Core	Wedge
N102 E50		11	Fragment	83.99	54.81	21.53	21.53	44.95	56	Blade Core	Wedge
N122 E06	8	7	Complete	42.88	66.51	10.43	10.43	64.95	75	Blade Core	Wedge
N286 E136	12	11	Fragment	108.42	49.99			82.89	65	Blade Core	Wedge
TU9	2	10	Fragment	97.74	32.39	13.498	13.498	98.27	90	Blade Core	Wedge
N144 E42	11	14	Fragment	108.92	67.19	157.35	78.675	110.55	76	Blade Core	Ind
N144 E42	11	39	Fragment	60.32	50.7	55.08	6.89	60.81	85	Blade Core	Ind
N160 E56	TT	28	Fragment	78.91	85.2	141.58	23.59	57.4	NA	Blade Core	Ind
N104 E50	9	11	Fragment	70.18	24.5	33.61	3.36	43.74	NA	Blade Core	Ind
N114 E50	6	2	Fragment	69.46	54.63	53.32	13.33	46.88	NA	Blade Core	Ind
N240 E128	3	4	Fragment	33.94	88.68			40.58	NA	Blade Core	Ind
N150 E150	10	50	Fragment	134.42	87.54	248.58	27.62	61.18	71	Blade Core	Ind

Appendix IV. Morphological Attributes of Cores

Morphologic Attributes

Provenience			Portion	Length	Width	Weight	W/RS Ratio	RS length	Angle	Interpretation	
N158 E56	TT	1	Fragment	38.92	83.2	181.21	18.12	30.67	71	Flake Core	Bi-direct
TU 5	3	2	Complete	51.64	100.15	386.11	27.58	66.46	62	Flake Core	Bi-direct
TU 5	4	7	Complete	81.08	63.59	164.7	14.97	47.96	76	Flake Core	Bi-direct
N120 E50	10	6	Complete	30.11	87.5	98.85	8.23	37.63	65	Flake Core	Conical
N144 E42	10	28	Complete	124.44	130.15	1394.95	77.5	74.15	76,75,80	Flake Core	Multi-Direct
N158 E56	TT	7	Fragment	51.49	112.42	218.73	27.34	90.68	66	Flake Core	Multi-Direct
N288 E136	12	2	Complete	118.66	67.09	319.75	22.84	60.74	77,60	Flake Core	Multi-Direct
N158 E56	TT	5	Face	128.94	76.14	422.26	NA	NA	NA	Flake Core	NA
N104 E48	10	7	Complete	50.39	83.13	137.26	9.15	25.28	85	Gen.Core	Amorphous
N104 E50	10	12	Complete	47.34	59.08	146.98	6.99	45.93	77,70	Gen.Core	Amorphous
N114 E50	10	26	Complete	129.77	123.78	840.3	49.42	66.52		Gen.Core	Amorphous
N138 E136	5	4	Complete	69.24	50.9	79.61	6.63	46.93	56	Gen.Core	Amorphous
N138 E136	7	7	Complete	87.18	79.91	338.66	19.92	51.89	55	Gen.Core	Amorphous
N138 E136	8	17	Complete	64	76.83	98.75	10.97	NA	NA	Gen.Core	Amorphous
N138 E136	8	6	Complete	39.93	60.4	35.35	4.41	38	78	Gen.Core	Amorphous
N138 E136	8	29	Complete	72.55	46.72	116.7	11.67	46.21	NA	Gen.Core	Amorphous
N144 E42	10	74	Complete	53.51	71.12	122.93	6.82	44.64	75,50	Gen.Core	Amorphous
N160 E56	TT	42	Complete	26.15	14.06			16.63	NA	Gen.Core	Amorphous
N160 E56	TT	40	Complete	49.18	28.77	32.9	3.65	25.62	NA	Gen.Core	Amorphous
N160 E56	TT	41	Complete			73.7	8.18	38.92	NA	Gen.Core	Amorphous
N172 E062	11	24	Complete	78.86	88.11	395.51	19.77	36.54	65	Gen.Core	Amorphous
N172 E62	11	25	Complete	76.75	52.27	136.25	5.45	50.93	73	Gen.Core	Amorphous
N248 E142	11	2	Complete	68.9	66.38	221.15	13	40.68	NA	Gen.Core	Amorphous

Appendix IV. Morphological Attributes of Cores

Morphologic Attributes

Provenience			Portion	Length	Width	Weight	W/RS Ratio	RS length	Angle	Interpretation	
N284 E134	10	30	Complete	70.3	101.6	492.39	37.8	61.18	80-85	Gen.Core	Amorphous
N284 E134	10	29	Complete	1001.58	66.58	239.86	14.99	50.52	85	Gen.Core	Amorphous
N286 E138	12		Complete	34.2	81.67	145.55	10.4	37.27	79	Gen.Core	Amorphous
TU 4	2	11	Fragment	59.29	26.78	68.05	11.34	53.37	NA	Gen.Core	Amorphous
TU 4	2	1	Complete	32.87	83.12	175.71	13.516	42.25	80	Gen.Core	Amorphous
TU 5	3	6	Complete	56.49	112.4	422.68	30.19		60	Gen.Core	Amorphous
TU 5	3	8	Fragment	68.03	113.57	288.81	24.06	45	52	Gen.Core	Amorphous
TU 5	5	1	Complete	74.87	91.35	298.17	19.878	48.49	70	Gen.Core	Amorphous
TU 8	6	2	Complete	106.35	120.81	868.9	48.27	43.01	65	Gen.Core	Amorphous
N104 E48	8	39	Complete	95.93	65.04	266.93	24.26	30.34	70	Gen.Core	Bi-direct
N122 E64	8	14	Complete	38.46	77.15	147	10.5	34.55	68	Gen.Core	Conical
N144 E42	11	31	Fragment	72.28	43.19	91.69	30.56	55.97	NA	Gen.Core	Ind
N160 E56	TT	46	Fragment	58.61	44.74	23.26	2.58	20.3	NA	Gen.Core	Ind
N114 E50	11	2	Complete	92.56	82.51	352.36	25.16	61.9	75	Gen.Core	Multi-Direct
N122 E064	8	37	Complete	70.53	100.58	324.99	15.47	63.1	66	Gen.Core	Multi-Direct
N122 E064	8	29	Complete	42.96	89.16	197.83	10.4	29.79	58	Gen.Core	Multi-Direct
N144 E42	11	18	Fragment	52.2	63.22	101.83	20.36	54.75	50,70,75	Gen.Core	Multi-Direct
N172 E062	9	2	Fragment	28.14	35.21	34.38	3.82	25.86	NA	Gen.Core	Multi-Direct
N284 E134	11		Complete	59.55	40.61			45.77		Gen.Core	Multi-Direct
N284 E136	10	26	Fragment	87.67	108.47	373.68	28.74	38.54	50,75	Gen.Core	Multi-Direct
N284 E136	10	2	Complete	30.42	62.98	62.78	2.51	31.94	50,55,60	Gen.Core	Multi-Direct
N286 E136	10		Fragment	92.5	49.72	147.79	9.85	61.79	71,90,74	Gen.Core	Multi-Direct

Appendix IV. Morphological Attributes of Cores

Provenience			Portion	Length	Width	Weight	W/RS Ratio	R/S length	Angle	Interpretation	
			Morphologic Attributes								
N286 E134	9	6	Fragment	81.84	58.93	111.46	11.146	49.11	56	Gen.Core	Amorphous
N286 E134	9	5	Complete	51.77	83.75	211.41	11.745	23.81	79	Gen.Core	Amorphous
TU 6	5	7	Fragment	105.73	82.84	476.33	47.633	38.31	46	Gen.Core	Amorphous
N172 E062	9	5	Fragment	96.89	125.74	446.49	34.33	78.91	86	Gen.Core	Bi-direct
N144 E42	11	8	Fragment	48.11	30.04	36.87	5.26	32	NA	Gen.Core	Ind
N144 E42	10	65	Fragment	48.41	38.42	70.64	14.12	46.25	NA	Gen.Core	Ind
N170 E62	10	101	Fragment	41.67	102.15	98.78	10.97	54.04	62	Gen.Core	Ind
N114 E50	10	42	Complete	92.56	82.51	352.36	25.17	60.22	75	Gen.Core	Multi-Direct
N114 E50	10	19	Complete	59.81	51.08	249.52	16.63		66	Gen.Core	Multi-Direct
N150 E50	10	34	Complete	109.15	76.52	648.39	49.87	33.12	45	Gen.Core	Multi-Direct
N152 E50	10	15	Complete	195.67	76.5	1667.18	57.48	56.97	61	Gen.Core	Multi-Direct
N152 E50	10	6	Complete	130.68	98.81	644.18	53.68	83.21	55,86,87	Gen.Core	Multi-Direct
N158 E56	TT	40	Complete	59.5	101.4	342.95	28.579	35.16	60	Gen.Core	Amorphous
N284 E134	9	10	Complete	39.84	104.7	173.15	13.31	39.03	77	Gen.Core	Amorphous
N144 E42	12	4	Fragment	73.06	36.46	30.85	15.42	55.57	NA	Indeterminate	Ind
N170 E62	10	81	Fragment	49.95	17.99	38.52	5.5	NA	67	Indeterminate	Ind
TU 7	5	8	Fragment	101.85	55.15	88.11	14.685	101.58	NA	Indeterminate	Ind
N170 E62	10	39	Fragment	53.07	79.03	93.89	7.22	33.16	74	Indeterminate	Multi-Direct
N284 E134	10	10	Fragment	78.07	44.7	102.04	12.75	56.48	75	Indeterminate	Multi-Direct

Appendix V

Morphological Attributes of Isolated Blade Discoveries

Appendix V

Morphological Attributes of Isolated blade Discoveries.

	Portion	Weight	L	W	I/C	Plat W	Plat Th	Th prox.	Th dist.	# Scars
1	complete	14	95.8	19.5	2.68	9.5	2.9	4.3	6.9	5
2	complete	NA	117.6	25.4	Slight			NA	NA	3
3	complete	NA	91.9	34.5	NA	NA	NA	NA	NA	5
4	complete	68.3	124.88	47.26	8.11	17.3	7.15	9.84	13.4	4
5	proximal	20.2	57.3	36.3	NA	NA	NA	NA	NA	6
6	proximal	5	29.22	22.8	NA	6.47	2.58	6.29	NA	3
7	proximal	9	50.3	24.5	NA	13.1	4.9	6.5	NA	3
8	complete	16.9	74.32	36.18	6.4	6.4	3.68	5.87	8.41	2
9	medial	8	59.6	21.2	NA	NA	NA	NA	NA	2
10	proximal	9	48.6	26.9	NA	3.7	2	7.2	7.2	2
11	complete	NA	84	27.8	0	11.04	3.2	10.01	10.03	5
12	complete	NA	NA	NA	NA	NA	NA	NA	NA	2
13	complete	NA	NA	NA	NA	NA	NA	NA	NA	2
14	complete	24	89.8	24	5.01	NA	3.5	NA	NA	5
15	proximal	NA	50	25.1	NA	NA	NA	NA	NA	3

Appendix VI

Photo Number of Blades

Appendix VI. Photo #

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
TU 11	complete	73.11	21.06	6.37	Bi-directional	Blade	001 through 003	12
TU 11	complete	83.55	20.2	5.52	Uni-directional	Blade	004 through 006	11
N102 E42	complete	106	32.64	15.95	Bi-directional	Blade	007 through 009	11
N100 E40	complete	125.24	40.25	8.84	Bi-directional	Blade	010 through 012	11
N100 E38	complete	112.62	34.13	9.84	Multi-directional	Blade	013 through 015	9
N102 E40	complete	111.05	30.39	6.76	Uni-directional	Blade	016 through 018	9
N100 E38	distal fragment	82.17	27.75	2.53	Multi-directional	Blade-like-flake, distal	019 through 021	6
N102 E40	complete	95.23	33.74	7.45	Bi-directional	Blade	022 through 024	10
N102 E54	complete	95.14	36.09	4.1	multi-directional	Blade	025 through 027	7
N102 E54	complete	141.38	67.2	9.05	Multi-directional	Blade	028 through 030	8
N100 E62	proximal fragment	68.86	51.5	2.99	Uni-directional	Blade, proximal	030 through 033	9
N102 E64	proximal fragment	48.26	35.33	0	Uni-directional	Blade, proximal	034 through 036	11
N100 E40	proximal fragment	44.76	27.85	5.16	bi-directional	Blade, proximal	037 through 039	11
BHT 15	complete	99.24	28.46	7.4	Bi-directional	Blade	040 through 042	11
N242 E128	complete	57.57	20	6.87	Bi-directional	Blade-like-flake	043 through 045	6
N242 E128	proximal fragment	24.64	29.21	0	Uni-directional	Blade, proximal	046 through 048	11
N242 E128	distal fragment	26.94	17.94	0	Bi-directional	Blade, distal	049 through 051	8
N242 E128	medial fragment	32.11	29.67	0	Uni-directional	Blade, medial	052 through 053	8
N242 E128	distal fragment	44.01	23.06	0	Uni-directional	Blade, distal	054 through 055	8
N242 E128	complete	43.17	12.58	0	Uni-directional	Blade	056 through 057	11
N242 E128	medial fragment	25.68	23.58	0	Uni-directional	Blade, medial	058 through 059	8
N242 E128	distal fragment	37.81	31.91	3.43	Uni-directional	Blade-like-flake, distal	060 through 061	6
N244 E128	proximal fragment	35.58	8.9	6.85	Uni-directional	Blade, proximal	062 through 063	12
N234 E106	complete	92.95	24.29	6.94	Uni-directional	Blade	064 through 066	11
N234 E106	distal fragment	80.54	21.62	11.54	multi-directional	Blade-like-flake, distal	067 through 069	5
N104 E50	medial fragment	75.48	41.12	5.8	uni-directional	Blade, medial	070 through 071	8
N240 E128	complete	54.42	10.45	0	Bi-directional	Blade	072 through 073	11

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
TU 5	complete	142.85	34.35	6.49	Bi-directional	Blade	074 through 076	11
N104 E48	complete	139.73	58.22	7.9	Uni-directional	Blade	077 through 079	10
TU 04	complete	92.71	37.71	2.83	Bi-directional	Blade	080 through 082	8
N238 E134	complete	54.74	21.86	4.14	Uni-directional	Blade	083 through 084	9
N246 E142	complete	51.31	13.41	4.63	Uni-directional	Blade	085 through 086	11
N244 E136	medial fragment	23.97	9.51	0	Uni-directional	Blade Medial	087 through 088	8
N238 E134	complete	55.83	18.32	4.78	Uni-directional	Blade	089 through 90	7
N276 E152	medial fragment	30.14	39.99	0	Uni-directional	Blade, medial	091 through 092	8
N244 E136	distal fragment	42.25	15.16	0	Uni-directional	Blade, distal	093 through 094	8
Roadbed	proximal fragment	37.46	35.52	0	Uni-directional	Blade, proximal	095 through 096	11
Roadbed	medial fragment	72.87	46.57	0	Multi-directional	Blade-like-flake, me-dial	097 through 098	5
N284 E134	proximal fragment	62.89	31.89	NA	Uni-directional	Blade, proximal	099 through 100	9
N284 E134	distal fragment	37.43	11.19	0	Uni-directional	Blade, distal	101 through 102	8
N284 E134	complete	60.74	21.92	4.6	Uni-directional	Blade	103 through 104	9
N104 E48	complete	73.78	24.91	0	Bi-directional	Blade	105 through 106	12
N104 E48	complete	72.36	28.91	9.78	Uni-directional	Blade	107 through 108	9
N104 E48	complete	39.3	13.97	4.5	Uni-directional	Blade	109 through 110	11
N104 E48	complete	40.69	14.32	2.33	Uni-directional	Blade	111 through 112	8
N104 E48	medial fragment	21.86	17.3	0	Uni-directional	Blade, medial	113 through 114	8
N104 E48	complete	53.48	28.05	13.16	Multi-directional	Blade-like-flake	115 through 116	6
N104 E48	complete	56.59	15.58	7.4	Uni-directional	Blade	117 through 118	11
N104 E48	complete	58.11	19.24	6.19	Uni-directional	Blade	119 through 120	12
N104 E48	complete	83.54	28.64	0	Bi-directional	Blade	121 through 122	11
N170 E62	medial fragment	61.79	47.61	0	Uni-directional	Blade, medial	123 through 124	8
N170 E62	complete	97.73	31.08	6.74	Uni-directional	Blade	125 through 126	12
N170 E62	proximal fragment	37.88	23.5	0	Uni-directional	Blade, proximal	127 through 128	11
N170 E62	proximal fragment	46.45	28.33	0	Uni-directional	Blade, proximal	129 through 130	10

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N170 E62	complete	80.88	34.48	0	Uni-directional	Blade	131 through 132	8
N170 E62	complete	52.08	22.42	10.86	Bi-directional	Blade, crest	133 through 134	11
N170 E62	medial fragment	30.08	20.38	0	Uni-directional	Blade, medial	135 through 136	8
N170 E62	complete	68.55	23.12	5.57	Uni-directional	Blade-like-flake	137 through 138	6
N170 E62	proximal fragment	34.13	28.24	0	Uni-directional	Blade, proximal	139 through 140	11
N170 E62	complete	60.47	26.8	8.45	Uni-directional	Blade	141 through 142	9
N170 E62	complete	78.87	36.42	6.87	multi-directional	Blade-like-flake	143 through 144	6
N104 E50	complete	66.2	28.11	3.957	Uni-directional	Blade	145 through 146	8
N104 E50	medial fragment	35.87	29.69	0	Uni-directional	Blade, medial	147 through 148	9
N104 E50	distal fragment	51.79	20.69	0	Uni-directional	Blade-like-flake, distal	149 through 150	6
N104 E50	complete	71	29.63	4.04	Bi-directional	Blade, corner	151 through 152	12
N114 E50	complete	51.19	14.74	4.53	Uni-directional	Blade	153 through 154	11
N172 E62	complete	59.47	17.44	5.36	Uni-directional	Blade	155 through 156	10
N172 E62	complete	79.02	31.31	4.41	Multi-directional	Blade-like-flake	157 through 158	5
N288 E136	complete	143.9	47.66	0	Uni-directional	Blade	159 through 160	11
N122 E64	complete	112.39	37.33	7.26	Uni-directional	Blade, starter	161 through 162	9
N122 E64	proximal fragment	25.61	28.74	0	Uni-directional	Blade, proximal	163 through 164	10
N144 E42	complete	56.31	26.09	2.58	Uni-directional	Blade-like-flake	165 through 166	6
N144 E42	proximal fragment	34.72	41.24	0	Uni-directional	Blade, proximal	167 through 168	11
N144 E42	complete	73.12	30.71	10.16	Multi-directional	Blade-like-flake, crest	169 through 170	6
N144 E42	distal fragment	41.39	29.88	3.43	Bi-directional	Blade, distal	171 through 172	9
N144 E42	distal fragment	58.2	17.22	0	Uni-directional	Blade, distal	173 through 174	10
N144 E42	complete	77.12	36.16	7.78	Multi-directional	Blade-like-flake	175 through 176	6
N144 E42	proximal fragment	28.62	26.3	0	Uni-directional	Blade, proximal	177 through 178	11
N144 E42	complete	55.77	15.59	4.55	Bi-directional	Blade	179 through 180	8
N170 E62	proximal fragment	40.62	37.48	0	Uni-directional	Blade, proximal	181 through 182	11
N172 E62	complete	60.62	19.43	0	Uni-directional	Blade	183 through 184	8

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N170 E62	complete	48.15	10.91	0	Uni-directional	Blade-like-flake	185 through 186	5
N170 E62	complete	33.23	35.88	0	Uni-directional	Blade	187 through 188	7
N170 E62	complete	64.04	31.56	0	Uni-directional	Blade	189 through 190	11
N172 E62	complete	63.17	26.35	0	Uni-directional	Blade	191 through 192	9
N148 E48	medial fragment	47.7	30.66	7.29	Bi-directional	Blade, medial	193 through 194	8
N148 E48	complete	45.16	24.05	0	Multi-directional	Blade-like-flake	195 through 196	6
N148 E48	complete	57.47	25.44	4.8	Multidirectional	Blade-like-flake	197 through 198	4
N148 E48	proximal fragment	33.03	36.03	0	Uni-directional	Blade, proximal	199 through 200	11
N148 E48	distal fragment	38.14	30.22	0	Uni-directional	Blade, distal	201 through 202	8
N148 E48	complete	57.9	23.21	0	Uni-directional	Blade	203 through 204	7
N172 E62	distal fragment	48.34	25.2	6.68	Multidirectional	Blade-like-flake, distal	205 through 206	0
N172 E62	medial fragment	42.28	19.43	7.61	Uni-directional	Blade-like-flake, medial	207 through 208	5
N172 E62	complete	100.1	40.21	7.86	Multi-directional	Blade, crest	209 through 211	8
N172 E62	complete	50.05	26.32	0	Uni-directional	Blade	212 through 213	7
N172 E62	medial fragment	56.25	21.75	4.72	Uni-directional	Blade-like-flake, medial	214 through 215	5
N172 E62	complete	64.2	25.44	0	Uni-directional	Blade	216 through 217	8
N286 E138	complete	64.64	19.61	0	Uni-directional	Blade	218 through 219	9
N286 E138	complete	80.31	23.35	1.33	Uni-directional	Blade	220 through 221	12
N286 E138	complete	75.82	42.39	0	Uni-directional	Blade	222 through 223	9
N286 E138	proximal fragment	53.07	34.33	0	Bi-directional	Blade, proximal	224 through 225	11
N286 E138	complete	80.63	31.87	2.46	Uni-directional	Blade	226 through 227	8
N286 E138	medial fragment	59.45	29.82	7.7	Bi-directional	Blade, medial	228 through 229	8
N286 E138	complete	74.24	33.43	4.64	Uni-directional	Blade	230 through 231	11
N286 E138	complete	73.24	30.55	9.58	Bi-directional	blade	232 through 233	7
N286 E138	complete	68.87	26.16	0	Uni-directional	blade	234 through 235	12
N286 E138	complete	52.86	18.53	7.25	multi-directional	Blade-like-flake	236 through 237	5
N286 E138	complete	61.24	20.36	3.6	Uni-directional	Blade	238 through 239	11

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N286 E138	proximal fragment	28.91	23.61	0	Uni-directional	Blade, proximal	240 through 241	11
N286 E136	complete	43.42	14.86	0	Uni-directional	Blade-like-flake	242 through 243	6
N286 E136	complete	53.89	15.71	7.25	Uni-directional	Blade	244 through 245	9
N286 E136	medial fragment	32.76	31.95	0	Uni-directional	Blade-like-flake, medial	246 through 247	5
N286 E136	complete	44.31	13.46	7.47	Bi-directional	Blade-like-flake	248 through 249	3
N170 E 62	complete	42.77	17.71	5.63	Uni-directional	Blade-like-flake	250 through 251	5
N170 E 62	proximal fragment	44.28	37.21	NA	Uni-directional	Blade, proximal	252 through 253	9
N284 E134	complete	111.75	41.13	8.02	Uni-directional	Blade, starter	254 through 255	8
N284 E134	medial fragment	19.46	11.15	0	Uni-directional	Blade-like-flake, medial	256 through 257	6
N284 E134	complete	46.5	23.63	9.56	Uni-directional	Blade	258 through 259	10
N284 E134	complete	30.13	14.19	0	Uni-directional	Blade-like-flake	260 through 261	6
N284 E134	distal fragment	31.83	16.13	0	Uni-directional	Blade-like-flake, distal	262 through 263	3
N284 E134	medial fragment	8.03	23.36	0	Uni-directional	Blade-like-flake, med.	264 through 265	5
N284 E134	complete	62.56	27.55	11.02	multi-directional	Blade-like-flake	266 through 267	4
N284 E134	proximal fragment	41.87	31.32	4.65	Bi-directional	Blade, proximal	268 through 269	9
N284 E134	complete	69.81	35.22	0	multi-directional	Blade-like-flake	270 through 271	1
N284 E134	complete	48.26	20.08	0	Uni-directional	Blade-like-flake	272 through 273	6
N284 E134	complete	62.03	31.53	10.05	multi-directional	Blade-like-flake, crest	274 through 275	6
N284 E134	medial fragment	16.97	14.22	NA	Bi-directional	Blade, medial	276 through 277	8
N284 E134	distal fragment	35.98	15.5	3.83	Uni-directional	Blade, distal	278 through 279	8
N284 E134	complete	12.09	6.07	0	Uni-directional	Blade	280 through 281	11
N284 E134	medial fragment	6.32	20.49	0	Uni-directional	Blade, medial	282 through 283	8
N286 E136	complete	41.59	18.91	0	Uni-directional	Blade	284 through 285	9
N286 E136	complete	62.16	22.15	3.33	multi-directional	Blade-like-flake, crest	286 through 287	3
N286 E134	medial fragment	60.85	24.62	4.66	Uni-directional	Blade, medial	288 through 289	8
N286 E134	proximal fragment	34.53	12.75	8.22	Uni-directional	Blade, proximal	290 through 291	10
N286 E134	complete	44.78	15.67	6.16	Uni-directional	Blade	292 through 293	12

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N286 E134	complete	46.02	16.97	0	Uni-directional	Blade	294 through 295	7
N286 E134	complete	36.77	15.89	0	Uni-directional	Blade	296 through 297	9
N286 E134	complete	41.08	15.53	0	Uni-directional	Blade	298 through 299	9
N286 E134	complete	42.44	25.14	NA	Uni-directional	Blade-like-flake	300 through 301	4
N286 E134	complete	66.54	33.26	0	Uni-directional	Blade, starter	302 through 303	9
N286 E134	complete	40.58	20.1	5.19	Uni-directional	Blade-like-flake	304 through 305	4
N286 E134	medial fragment	22.59	24.62	NA	Uni-directional	Blade, medial	306 through 307	8
N286 E134	complete	46.46	15.36	0	Uni-directional	Blade	308 through 309	10
N286 E134	proximal fragment	19.36	21.22	NA	Uni-directional	Blade, proximal	310 through 311	11
N286 E134	complete	46.7	19.82	6.4	Uni-directional	Blade	312 through 313	9
N286 E134	complete	37.37	18.24	5.72	Uni-directional	Blade	314 through 315	8
N286 E134	distal fragment	30.57	12.59	0	Uni-directional	Blade, distal	316 through 317	8
N286 E134	complete	34.22	13.52	0	Uni-directional	Blade	318 through 319	11
N286 E134	complete	37.8	12.52	0	Uni-directional	Blade	320 through 321	8
TU 7	complete	51.27	23.6	0	Bi-directional	Blade, corner	322 through 323	10
TU 7	complete	43.94	20.7	0	Uni-directional	Blade	324 through 325	10
TU 7	proximal fragment	25.34	31.77	0	multi-directional	Blade, proximal	326 through 327	8
TU 7	proximal fragment	24.78	33.96	0	multi-directional	Blade-like-flake, proximal	328 through 329	6
TU 8	complete	66.42	24.98	9.22	Bi-directional	Blade, starter	330 through 331	9
TU 8	distal fragment	71.46	29.58	3.2	Uni-directional	Blade, distal	332 through 333	8
TU 8	complete	83.76	21.16	2.99	multi-directional	Blade, crest	334 through 335	8
N158 E56	distal fragment	61.63	18.02	0	Uni-directional	Blade-like-flake, distal	336 through 337	3
N158 E56	medial fragment	50.91	27.91	7.54	Uni-directional	Blade, medial	338 through 339	9
N158 E56	complete	65.87	26.3	0	Multi-directional	Blade-like-flake	340 through 341	6
N158 E56	medial fragment	35.82	29.04	5.3	Bi-directional	Blade, medial	342 through 343	8
N158 E56	medial fragment	40.97	27.02	0	uni-directional	Blade, medial	344 through 345	9
N158 E56	complete	47.1	12.47	0	Uni-directional	Blade	346 through 347	11

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N150 E50	complete	52.03	26.13	12.27	Multi-directional	Blade-like-flake	348 through 349	1
N150E50	complete	64.86	21.21	4.68	Multi-directional	Blade-like-flake	350 through 351	0
N150 E150	medial fragment	37.15	30.83	NA	Uni-directional	Blade, medial	352 through 353	8
N150 E50	complete	85.69	40.49	9.24	Multi-directional	Blade-like-flake, crest	354 through 355	2
N150 E 50	proximal fragment	41.38	24.77	0	Uni-directional	Blade, proximal	356 through 357	9
N152 E50	complete	50.08	30.42	NA	Uni-directional	Blade-like-flake	358 through 359	6
N152 E50	complete	73.18	33.67	11.43	Uni-directional	Blade, crest	360 through 361	11
N152 E 50	complete	69.43	37.21	0	Uni-directional	Blade	362 through 363	8
N114 E50	complete	42.96	19.71	6.23	Uni-directional	Blade	364 through 365	7
N160 E56	medial fragment	57.13	14.78	3.79	Uni-directional	Blade, medial	366 through 367	8
N160 E56	medial fragment	65.14	22.69	10.02	Multi-directional	Blade-like-flake, medial	368 through 369	3
N160 E56	proximal fragment	38.87	24.27	0	Uni-directional	Blade, proximal	370 through 371	11
N160 E56	complete	67.5	36.82	0	Uni-directional	Blade	372 through 373	9
N138 E36	complete	114.87	36.02	14.45	Multi-directional	Blade, crest	374 through 375	9
N138 E36	complete	79.88	36.32	0	Bi-directional	Blade-like-flake	376 through 377	3
N138 E36	complete	44.38	23.39	5.15	Uni-directional	Blade	378 through 379	9
N138 E36	proximal fragment	43.79	34.23	0	Uni-directional	Blade, proximal	380 through 381	10
N138 E36	complete	82.35	39.36	5.59	Uni-directional	Blade-like-flake	382 through 383	3
N138 E36	complete	51.33	27.47	0	Uni-directional	Blade	384 through 385	11
N138 E36	proximal fragment	56.46	25.42	0	Uni-directional	Blade, proximal	386 through 387	11
N138 E36	complete	64.63	22.36	7.87	Uni-directional	Blade	388 through 389	11
N138 E36	complete	62.2	13.35	3.53	Uni-directional	Blade	390 through 391	8
N138 E36	proximal fragment	57.27	38.26	0	Uni-directional	Blade, proximal	392 through 393	11
N138 E36	proximal fragment	64.34	53.62	0	Uni-directional	Blade, proximal	394 through 395	9
N138 E36	proximal fragment	35.41	14.82	3.19	Uni-directional	Blade-like-flake, proximal	396 through 397	6
TU 6	complete	53.36	21.51	0	Uni-directional	Blade	398 through 399	8
TU 6	complete	63.34	27.51	6.17	Uni-directional	Blade, crest	400 through 401	10

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N158 E56	complete	45.25	26.96	0	Uni-directional	Blade	402 through 403	12
TU 6	proximal fragment	14.63	17.45	NA	Uni-directional	Blade, proximal	404 through 405	11
TU 6	medial fragment	27.97	21.09	NA	Uni-directional	Blade, medial	406 through 407	8
TU 6	proximal fragment	21.41	22.98	NA	Uni-directional	Blade, proximal	408 through 409	11
TU 6	proximal fragment	36.18	23.89	0	Uni-directional	Blade, proximal	410 through 411	9
TU 6	complete	75.31	33	3.76	Bi-directional	Blade, crest	412 through 413	7
TU 6	complete	42.8	24.03	8.73	0	Blade-like-flake, corner	414 through 415	6
TU 6	complete	38.44	16.09	0	Uni-directional	Blade	416 through 417	11
TU 6	medial fragment	27.12	16.09	0	Uni-directional	Blade, medial	418 through 419	8
TU 6	complete	30.36	12	0	Uni-directional	Blade	420 through 421	12
TU 6	medial fragment	21.41	15.19	0	Uni-directional	Blade-like-flake, medial	422 through 423	6
TU 7	distal fragment	40.66	17.79	2.53	Uni-directional	Blade-like-flake, distal	424 through 425	6
TU 7	distal fragment	39.01	18.42	NA	Uni-directional	Blade, distal	426 through 427	8
TU 7	complete	47.34	14.71	1.68	Uni-directional	Blade-like-flake	428 through 429	6
TU 7	complete	57.3	26.34	5.81	multi-directional	Blade-like-flake	430 through 431	3
TU 7	complete	39.85	18.9	5.47	multi-directional	Blade-like-flake	432 through 433	3
TU 7	complete	42.51	21.08	0	Uni-directional	Blade	434 through 435	11
TU 7	complete	41.9	13.89	0	Uni-directional	Blade	436 through 437	12
TU 7	complete	76.79	31.1	10.19	multi-directional	Blade-like-flake, crest	438 through 439	6
TU 7	complete	63.01	24.64	7.34	multi-directional	blade-like-flake	440 through 441	5
TU 7	proximal fragment	28.76	17.62	0	Uni-directional	Blade, proximal	442 through 443	9
TU 7	complete	31.42	14.26	6.52	Uni-directional	Blade, starter	444 through 445	9
TU 7	medial fragment	24.1	20.84	NA	Uni-directional	Blade, medial	446 through 447	8
TU 7	complete	42.47	16.56	NA	Uni-directional	Blade, corner	448 through 449	8
TU 7	medial fragment	26.21	33.82	NA	Uni-directional	Blade, medial	450 through 451	8
TU 7	proximal fragment	23.1	20.48	NA	Uni-directional	Blade, proximal	452 through 453	9
TU 7	complete	33.33	15.03	5.49	Uni-directional	Blade	454 through 455	11

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
TU 7	medial fragment	20.05	18.68	NA	Uni-directional	Blade-like-flake, medi-al	456 through 457	6
TU 7	proximal fragment	26.91	17.34	NA	Uni-directional	Blade, proximal	458 through 459	9
TU 7	proximal fragment	14.98	20.82	NA	Uni-directional	Blade, proximal	460 through 461	11
TU 7	medial fragment	24.69	12.66	NA	Uni-directional	Blade, medial	462 through 463	8
TU 7	proximal fragment	33.48	22.14	0	Bi-directional	Blade, proximal	464 through 465	9
TU 7	proximal fragment	30.07	18.81	5.53	Uni-directional	Blade, proximal	466 through 467	10
TU 7	complete	38.73	12.24	2.58	Uni-directional	Blade	468 through 469	11
TU 7	proximal fragment	29.61	20.36	0	Indeterminate	Blade-like-flake, prox	470 through 471	5
TU 7	medial fragment	21.18	14.35	NA	Uni-directional	Blade, medial	472 through 473	8
TU 7	proximal fragment	16.69	14.83	NA	Uni-directional	Blade, proximal	474 through 475	11
TU 7	medial fragment	21.99	27.43	NA	Uni-directional	Blade-like-flake, medi-al	476 through 477	3
TU 7	distal fragment	21.12	19.99	NA	Bi-directional	Blade-like-flake, distal	478 through 479	6
TU 7	proximal fragment	22.25	12.62	NA	Uni-directional	Blade, proximal	480 through 481	9
TU 7	medial fragment	10.42	19.22	NA	Uni-directional	Blade, medial	482 through 483	8
TU 7	medial fragment	14.4	19.61	NA	Uni-directional	Blade, medial	484 through 485	8
TU 7	medial fragment	13.09	16.96	NA	Uni-directional	Blade-like-flake, medi-al	486 through 487	5
TU 9	complete	45.87	12.84	10.68	Uni-directional	Blade	488 through 489	7
TU 9	proximal fragment	36.71	25.37	0	Uni-directional	Blade, proximal	490 through 491	9
TU 9	proximal fragment	28.62	15.46	0	Uni-directional	Blade, proximal	492 through 493	11
TU 9	complete	40.74	14.15	0	Uni-directional	Blade	494 through 495	9
TU 9	medial fragment	13.89	14.51	0	Uni-directional	Blade, medial	496 through 497	8
TU 9	proximal fragment	14.78	17.03	0	Uni-directional	Blade, proximal	498 through 499	11
TU 9	complete	47.09	21.34	6.32	Uni-directional	Blade-like-flake	500 through 501	6
TU 9	complete	33.8	22.16	4.61	Uni-directional	Blade-like-flake	502 through 503	3
TU 9	proximal fragment	33.79	17.69	0	Uni-directional	Blade, proximal	504 through 505	11
TU 9	complete	53.78	10.77	2.39	Uni-directional	Blade	506 through 507	9
TU 10	complete	52.25	19.33	0	Uni-directional	Blade	508 through 509	11

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
TU 10	complete	77.36	47.05	4.86	Bi-directional	Blade, starter	510 through 511	9
TU 10	distal fragment	34.33	26.46	6.4	Uni-directional	Blade-like-flake, distal	512 through 513	6
TU 10	proximal fragment	41.87	30.48	4.7	Uni-directional	Blade, proximal	514 through 515	11
TU 10	distal fragment	61.47	25.79	0	Bi-directional	Blade-like-flake, distal	516 through 517	5
TU 10	medial fragment	44.16	21.2	0	Uni-directional	Blade, medial	518 through 519	9
TU 11	proximal fragment	28.52	16.24	0	multi-directional	Blade, proximal	520 through 521	8
TU 11	proximal fragment	39.26	34.17	0	Uni-directional	Blade, proximal	522 through 523	9
TU 5	complete	34.63	13.81	7.39	Uni-directional	Blade	524 through 525	11
TU 5	proximal fragment	42.26	20.73	10.45	Uni-directional	Blade, proximal	526 through 527	8
TU 5	complete	46.41	13.4	9.76	Uni-directional	Blade	528 through 529	8
TU 5	complete	38.91	11.9	5.37	Uni-directional	Blade, corner	530 through 531	11
TU 5	complete	58.16	19.17	0	Uni-directional	Blade, starter	532 through 533	11
TU 5	complete	37.9	12.48	0	Uni-directional	Blade	534 through 535	9
TU 5	distal fragment	33.12	13.61	2.77	Uni-directional	Blade-like-flake, distal	536 through 537	6
TU 5	distal fragment	31.81	13.22	0	Uni-directional	Blade, distal	538 through 539	8
TU 5	complete	63.11	20.2	5.45	Uni-directional	Blade	540 through 541	9
TU 5	proximal fragment	22.87	36.11	0	Uni-directional	Blade, proximal	542 through 543	9
TU 5	complete	45.38	19.75	0	Uni-directional	Blade, corner	544 through 545	11
TU 04	complete	75.05	32.63	NA	Bi-directional	Blade	546 through 547	11
TU 04	distal fragment	32.46	24.97	0	Uni-directional	Blade, distal	548 through 549	8
TU 04	proximal fragment	36.26	26.13	0	Uni-directional	Blade, proximal	550 through 551	9
TU 04	medial fragment	17.97	39.05	0	Uni-directional	Blade, medial	552 through 553	8
TU 04	medial fragment	20.93	28.1	NA	Uni-directional	Blade, medial	554 through 555	8
TU 04	complete	43.5	18.18	0	Uni-directional	Blade	556 through 557	11
TU 04	complete	57.13	16.31	0	Uni-directional	Blade	558 through 559	11
TU 04	complete	55.04	30	7.08	Uni-directional	Blade, corner	560 through 561	12
TU 04	proximal fragment	27.83	20.9	0	Uni-directional	Blade, proximal	562 through 563	11

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
TU 04	medial fragment	32.59	33.28	NA	Uni-directional	Blade, medial	564 through 565	9
TU 04	complete	68.91	28.11	9.44	Bi-directional	Blade	566 through 567	7
TU 04	complete	75.93	38.46	10.29	Bi-directional	Blade	568 through 569	8
TU 04	complete	81.81	47.56	2.11	Uni-directional	Blade	570 through 571	7
TU 04	complete	55.85	18.82	6.1	Uni-directional	Blade, crest	572 through 573	11
TU 04	complete	46.45	20.82	7.9	Bi-directional	Blade	574 through 575	11
TU 04	proximal fragment	29.04	28.71	0	Uni-directional	Blade, proximal	576 through 577	11
TU 04	complete	34.77	12.87	5.17	Uni-directional	Blade	578 through 579	11
TU 04	complete	67.85	38.59	0	Uni-directional/Bi-directional	Blade, corner	580 through 581	10
TU 04	complete	43.63	20.55	3.64	Uni-directional	Blade	582 through 583	10
TU 04	distal fragment	28.51	13.57	0	Uni-directional	Blade, distal	584 through 585	8
TU 04	complete	47.05	15.69	0	Uni-directional	Blade	586 through 587	11
TU 04	complete	39.02	11.2	0	Uni-directional	Blade	588 through 589	9
TU 04	distal fragment	24.27	13.75	0	Uni-directional	Blade-like-flake, distal	590 through 591	3
TU 11	complete	99.84	41.43	2.72	Bi-directional	Blade	592 through 593	10
TU 11	complete	76.37	37.59	6.93	Uni-directional	Blade	594 through 595	8
TU 11	complete	37.64	15.08	8.04	Uni-directional	Blade	596 through 597	10
TU 11	complete	84.75	50.93	13.5	multi-directional	Blade-like-flake	598 through 599	6
TU 9	proximal fragment	91.14	39.77	5.23	Uni-directional	Blade, proximal	600 through 601	9
TU 10	proximal fragment	25.56	24.94	0	Uni-directional	Blade, proximal	602 through 603	7
TU 10	complete	62.84	20.53	0	Uni-directional	Blade	604 through 605	11
TU 10	distal fragment	41.7	28.96	0	Uni-directional	Blade, distal	606 through 607	8
TU 5	complete	104.33	37.19	4.31	Uni-directional	Blade	608 through 609	9
N290 E132	complete	42.2	28.03	8.11	Bi-directional	Blade	610 through 611	9
N290 E132	complete	61.89	18.53	4.42	Uni-directional	Blade	612 through 613	10
N286 E132	complete	63.06	31.02	8.64	Uni-directional	Blade	614 through 615	9
N284 E 136	proximal fragment	46.21	36.25	0	Multi-directional	Blade, proximal	616 through 617	8

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
Roadbed	complete	83.82	34.19	0	multi-directional	Blade, crest	618 through 619	9
N286 E138	complete	33.61	11.87	0	Uni-directional	Blade-like-flake	620 through 621	4
N286 E138	medial fragment	34.42	16.11	NA	Uni-directional	Blade, medial	622 through 623	8
N286 E138	medial fragment	23.43	21.17	NA	Uni-directional	Blade, medial	624 though 625	8
N286 E138	proximal fragment	52.7	47.1	NA	Uni-directional	Blade, proximal	626 through 627	11
N286 E138	distal fragment	28.49	31.61	NA	Uni-directional	Blade-like-flake, distal	628 through 629	6
N286 E138	complete	34.87	20.08	NA	Uni-directional	Blade	630 through 631	10
N286 E138	complete	41.55	18.15	0	Uni-directional	Blade-like-flake	632 through 633	6
N286 E138	medial fragment	21	47.43	NA	Uni-directional	Blade, medial	634 through 635	8
N286 E138	proximal fragment	81.12	33.06	6.57	Bi-directional	Blade, proximal	636 through 637	11
N286 E138	proximal fragment	22.42	31.19	NA	Uni-directional	Blade, proximal	638 through 639	11
N286 E 138	complete	32.85	15.34	3.4	Uni-directional	Blade	640 through 641	11
N286 E138	distal fragment	26.14	27.91	NA	Bi-directional	Blade, distal	642 through 643	8
N286 E138	distal fragment	30	22.01	NA	Uni-directional	Blade-like-flake, distal	644 through 645	6
N286 E 136	complete	34.22	15	0	Uni-directional	Blade	646 through 647	11
N286 E 136	complete	39.57	16.03	0	Uni-directional	Blade	648 through 649	9
N286 E134	proximal fragment	34.72	11.31	NA	Uni-directional	Blade, proximal	650 through 651	8
N284 E134	complete	43.46	21.8	3.79	uni-directional	Blade-like-flake	652 through 653	6
N284 E134	complete	18.47	12.71	0	Uni-directional	Blade	654 through 655	8
N284 E134	medial fragment	15.04	11.24	0	Bi-directional	Blade, medial	656 through 657	8
N284 E134	complete	27.65	11.09	0	Uni-directional	Bladelet-like-flake	658 through 659	3
N122 E64	complete	95.22	28.4	12.39	Bi-directional	Blade, Crest	660 through 662	8
N104 E48	complete	139.52	58.05	7.97	Uni-directional	Blade, starter	663 through 664	11
N152 E50	complete	49.77	24.26	0	Multi-directional	Blade-like-flake		3
N1152 E50	complete	72.98	32.49	9.56	multi-directional	Blade-like-flake		3
N158 E56	complete	69.34	28.88	2.07	Multi-directional	Blade-like-flake		4
N138 E36	proximal fragment	51.11	26	0	Uni-directional	Blade-like-flake, proximal		4

Unit	Portion	L(max)	W(max)	Index Crv	Directionality	Type	Photo number	Score
N76 E182	complete	62.88	20.44	0	Uni-directional	Blade		7
N150 E 50	medial fragment	44.82	30.71	2.53	Uni-directional	Blade, medial		8
N288 E136	medial fragment	41.12	19.01	0	Uni-directional	Blade, medial		8
N160 E56	medial fragment	38.35	31.85	NA	Uni-directional	blade proximal		8
Roadbed	medial fragment	32.13	29.72	0	Uni-directional	Blade, medial		8
TU 11	proximal fragment	98.23	36.9	3.28	bi-directional	Blade, proximal		9
Roadbed	complete	91.61	24.17	9.24	Multi-directional	Blade, crest		9
TU 04	proximal fragment	38.11	26.68	NA	Bi-directional	Blade, proximal		11

Appendix VII

Spatial Analysis

Appendix VII

Spatial Analysis

The blades that I examined for this analysis derive from five excavation areas at the Topper site. These locations include (1) four 2X2m excavation units adjacent to a roadbed, and nearest to the chert outcropping (Area A). (2) A 64m sq. firebreak excavation along the South end of the hillside (Area B); (3) A 4X6 block excavation situated 10m to the north of the southern firebreak (Area C); (4) a northern firebreak excavation along the upper hill slope (Area D); and (5) units totaling 290msq. along an alluvial terrace adjacent to the Savannah River at the base of the hillside slope (Area E). A spatial analysis was conducted of the horizontal distribution of all identified blades and blade production debitage at Topper. This analysis reveals a number of patterns in onsite Clovis reduction strategies in addition to areas of site use. These patterns are discussed in detail below. The spatial distribution of all piece plotted blades, blade-like flakes, and cores recovered from each excavation area is provided in Figure (VII-1).

Blades

Based on the analyses of the plotted blades in areas A, B, C, and D, there does appear to be a relationship between the extent of onsite blade reduction and distance from the raw material source. For example, most identified blades (99) are from area A (Figure VII-2), the units adjacent to the roadbed. Excavation units placed here total 26 square meters in size. Thus, as of 2009, area A has the greatest density of blades per square meter than any area excavated to date. Most of the blades recovered from area A are complete, though there is a high frequency of blade proximal fragments. Nearly half of all proximal fragments identified from this analysis (48%) derive from area A. In contrast, medial and distal fragments occur sparingly. When all blades from area A were classified by type, most were found to be interior as opposed to primary or secondary reduction blades (Table VII-1), and exhibit little or no evidence of exterior surface cortex. Only three blades from area A were identified as primary decortication blades.
Four blades were identified from the Southern firebreak (area B). Of these, two are complete; one is a secondary blade and the other is interior. The other two blades from this area are both proximal blade fragments.

As one moves up the hill slope, and further from the raw material source, the number of identified blades decreases in quantity. A total of 76 blades were identified from the 4x6m block excavation, and excavation units from the northern firebreak (areas C and D). Moreover, it appears that a greater proportion of these blades were detached during early to middle stages of reduction, when compared to the blades recovered from area A. Thus, it would appear that the most intensive blade production episodes were occurring in areas closer to the chert source.

Most blades from area D were recovered from three 2x2m units. These include a single unit on the western end of the northern firebreak, unit N172 E162 on the Eastern end of the firebreak, and the adjacent N172 E160 unit (figure VII-3). The occurrence of blades was infrequent from the units between the extreme west and east ends of the northern firebreak.

Finally, 71 blades were identified from block excavation units conducted along the alluvial terrace at the base of the hill-slope and adjacent to the Savannah River (Figure VII-4). This area of the site represents the greatest volume of sediment that has been removed through excavation to date. Interestingly, blades from this area of the site tend to cluster in two distinct locations. These include the N242 E128 unit, and the N286 E138 unit of the terrace grid. Blades from these two units are most often complete and interior, with little evidence of primary blade manufacture. With the exception of these units, the occurrence of blades on the terrace is sparse. The intermittent occurrence of blades along the terrace hints at less intensive episodes of blade manufacture than found for other areas of the site.

Blade-like flakes

In contrast to the blades, blade-like-flakes are not found in great quantities from the excavation units alongside the roadbed (Area A), and seem instead to be concentrated in other areas of the site, notably the upper hillside (of Area D). The blade-like-flakes that do occur in area A however are predominantly interior, and have multiple scars of previous flake removals on the exterior surface. These flakes appear to be core rejuvenation and or error recovery flakes. Such artifacts should be expected where multiple sequences of the manufacture continuum are found to occur. Unlike the blade-like flakes recovered in area A, those identified from the hill-top excavation (Area D) are predominantly cortical and or secondary reduction flakes. These flakes are typically produced during early to middle stages of the reduction continuum, and may occur as the by-products of early stages of blade or biface manufacture. As found for the road side excavation units, there are also few blade-like flakes from the alluvial terrace (Figure VII-4, Table VII-2). However, those that do occur, were recovered from a single excavation unit (N242 E 128).

Cores

Blade cores have been recovered from multiple archaeological contexts at Topper (figures VII-5 and VII-6). Seventeen piece plotted artifacts have been identified as blade cores. These cores were classified by type: (wedge, conical, and cylindrical). Two of the cores are from area A, and are wedge in shape. These cores have relatively low weight to removal scar ratios (mean = 11.4) indicative of intensive blade reduction. There are three blade cores from area B, all wedge in shape. Most blade cores however are from areas C and D (9). This number includes six wedge cores, two conical cores, and a single cylindrical core. Blade cores are rare from the terrace, with only two cores having been identified from area E. Both of these are bi-directional wedge core fragments.

In addition to the blade cores, 51 piece plotted generalized amorphous cores have been identified from the sample. As is found for the blade cores, most generalized amorphous cores (32) were recovered from excavation area D. Ten cores were recovered from the alluvial terrace (E), while six were recovered from the roadside excavation units along the hillside slope (area A). Unlike blade cores, the generalized amorphous cores from area A exhibit high weight to removal scar ratios (24.43) suggesting low intensity flake production. In contrast, the generalized cores from area D exhibit lower ratios (18.54), indication of greater intensity in the production of flakes. Additional evidence in support of this pattern may be found in the higher proportion of blade-like flakes occurring from the hilltop (D) than from the roadbed excavation (A).

Spatial Interpretation

The results of the spatial analysis indicate that the area adjacent to the roadbed (A) was primarily utilized for blade manufacture. A higher ratio of blades per square meter was found to occur in this area when compared to other areas of the site. As distance increases away from the roadside units, late stage blade and blade production debitage decrease in frequency, while the incidence of blade-like-flakes increase. This pattern is illustrated in Figure (VII-7), which shows the distribution of piece plotted blades and blade-like flakes recovered from the roadside units (A), the southern firebreak (B), and the 4X6m excavation block (C). Likewise, figure (VII-8) presents the distribution of blades versus bifaces for these same proveniences. When the distribution of blades from block A was compared to the bifaces recovered from the site, Smallwood found a ratio of "roughly one biface for every seven blades" (Smallwood et al 2010). This pattern was found to be reversed in areas B and C.

Interestingly, very few blade cores have been recovered from area A. It is possible that the cores, upon exhaustion, were further reduced here, and discarded as indistinguishable core fragments. Such fragments thus may not exhibit attributes consistent with technological blade cores. The spatial distribution and condition of blades and blade-like-flakes at Topper suggests that some areas of the site were utilized by Clovis inhabitants for quarrying nodules of chert. Subsequent reduction episodes occurred in the form of initial and early stage blade and biface production. There is evidence that blade and biface tool manufacture activities are "spatially segregated" across the site (Smallwood 2010). At least one area of the site, notably the area adjacent to the roadbed (Area A), and nearest the raw material source, was utilized for more intensive late stage blade production. This pattern is in contrast with the distribution of bifaces, and more specifically, biface reduction intensity across the site. For example, Smallwood et al 2010 found that in areas closest to the outcrop, (Areas A and B), there are higher numbers of bifaces from early stages of the reduction continuum. On the other hand, in Block C, the area further up the hillside and away from the outcrop, bifaces occur most commonly as "discards, with greater extent of reduction, or are further along in the production process" Smallwood et al 2010.

Table VII-1. Number of artifacts by class for each excavation area at Topper (38AL23).

Provenience	Blades				BLF	
	Complete	Prox.	Dist.	Med.		Area (m sq.)
Area C and D	44 (33%)	17 (27%)	4 (24%)	11 (29%)	34 (41%)	165
Area B	2 (.2%)	2 (.3%)	0	0	0	64
Area A	50 (38%)	30 (48%)	5 (29%)	14 (37%)	22 (26%)	24
Area E	37 (29%)	13 (21%)	8 (47%)	13 (34%)	27 (33%)	290
Total	133	62	17	38	83	543

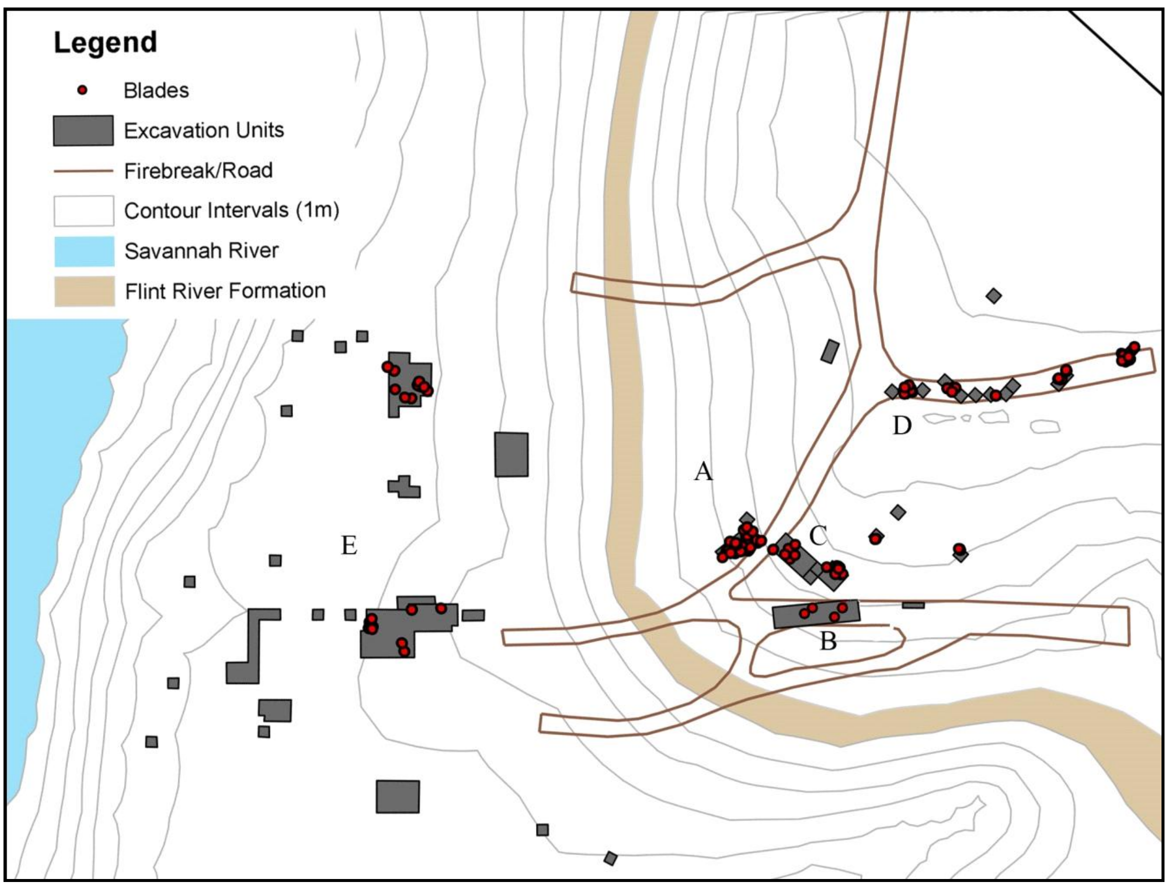


Figure VII-1.
Distribution of all piece plotted blades from the Topper Site. (Image courtesy of D.Shane Miller)

Table VII-2.

The Number of blades and blade-like flakes by Cortical Class for each excavation area.

	Cortical Class Blades (n)			Cortical Class BLF (n)			
	Primary	Secondary	Interior	Primary	Secondary	Interior	Total
Provenience							
C and D	0	22	54	0	15	19	110
B	1	2	1	0	0	0	4
A	3	18	78	0	4	18	121
E	0	11	60	0	6	21	98
Total	4	53	193	0	25	58	333

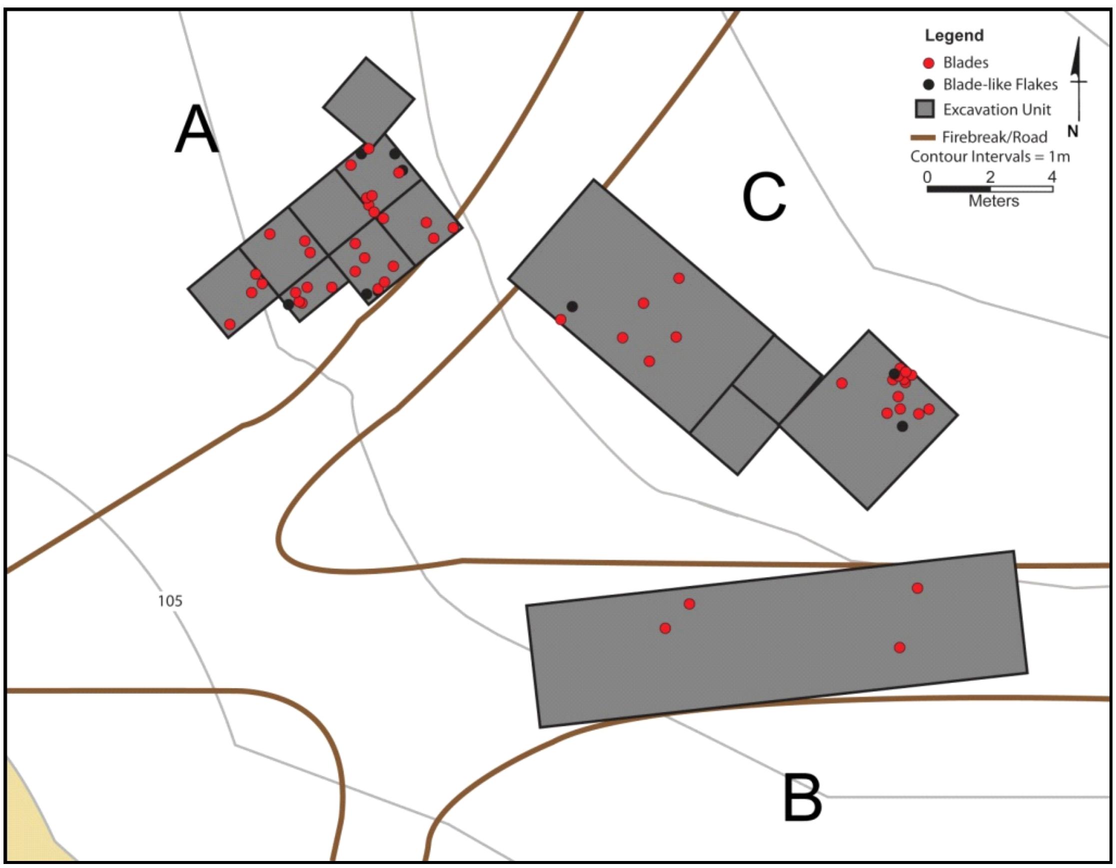


Figure VII-2.
The distribution of blades and blade like flakes from the roadside units (A), the Southern Fire-break (B), and the hillside (C) areas of the Topper site. Blades are most abundant from area A.

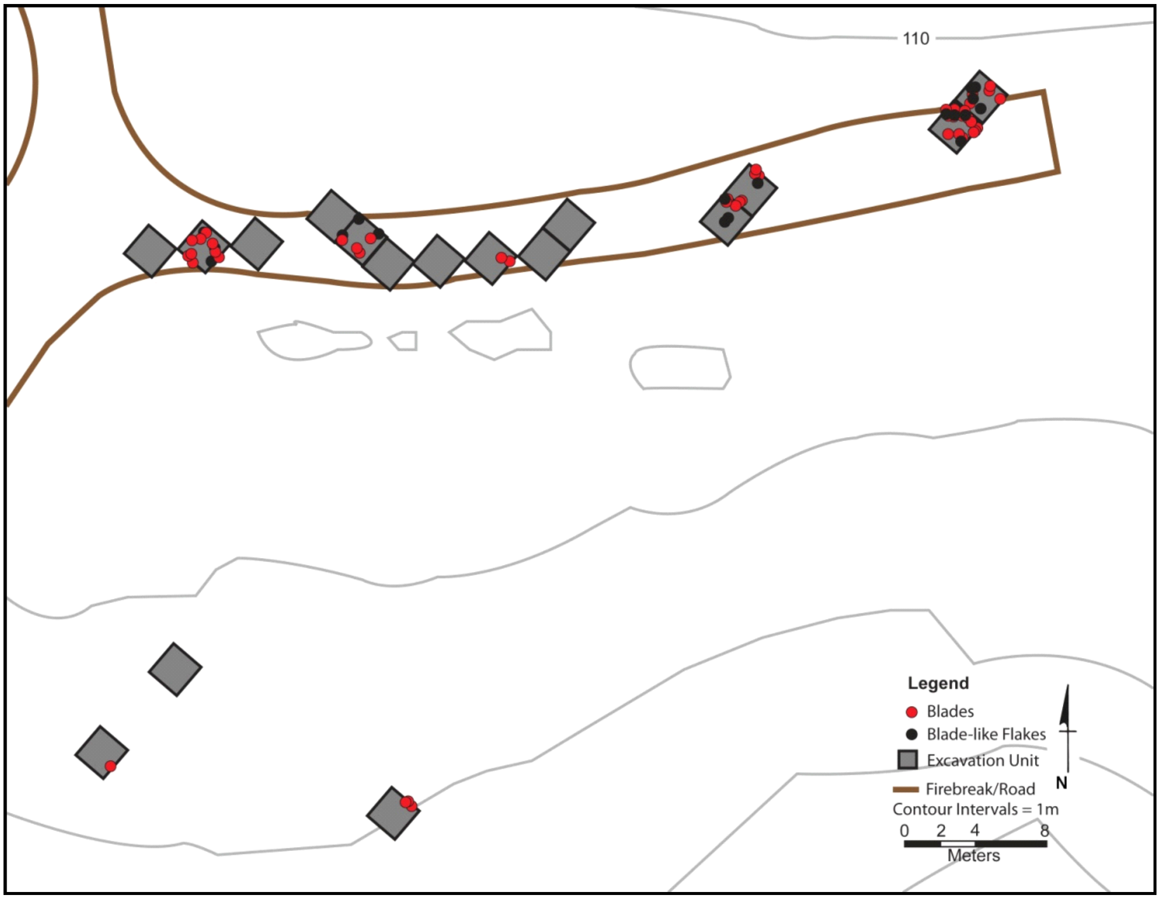


Figure VII-3.
The distribution of blades and blade-like flakes from the Northern Firebreak at Topper (Area D). Blade-like flakes increase with distance from the quarry. (Image courtesy of D. Shane Miller, adapted by Jessica Beltman).

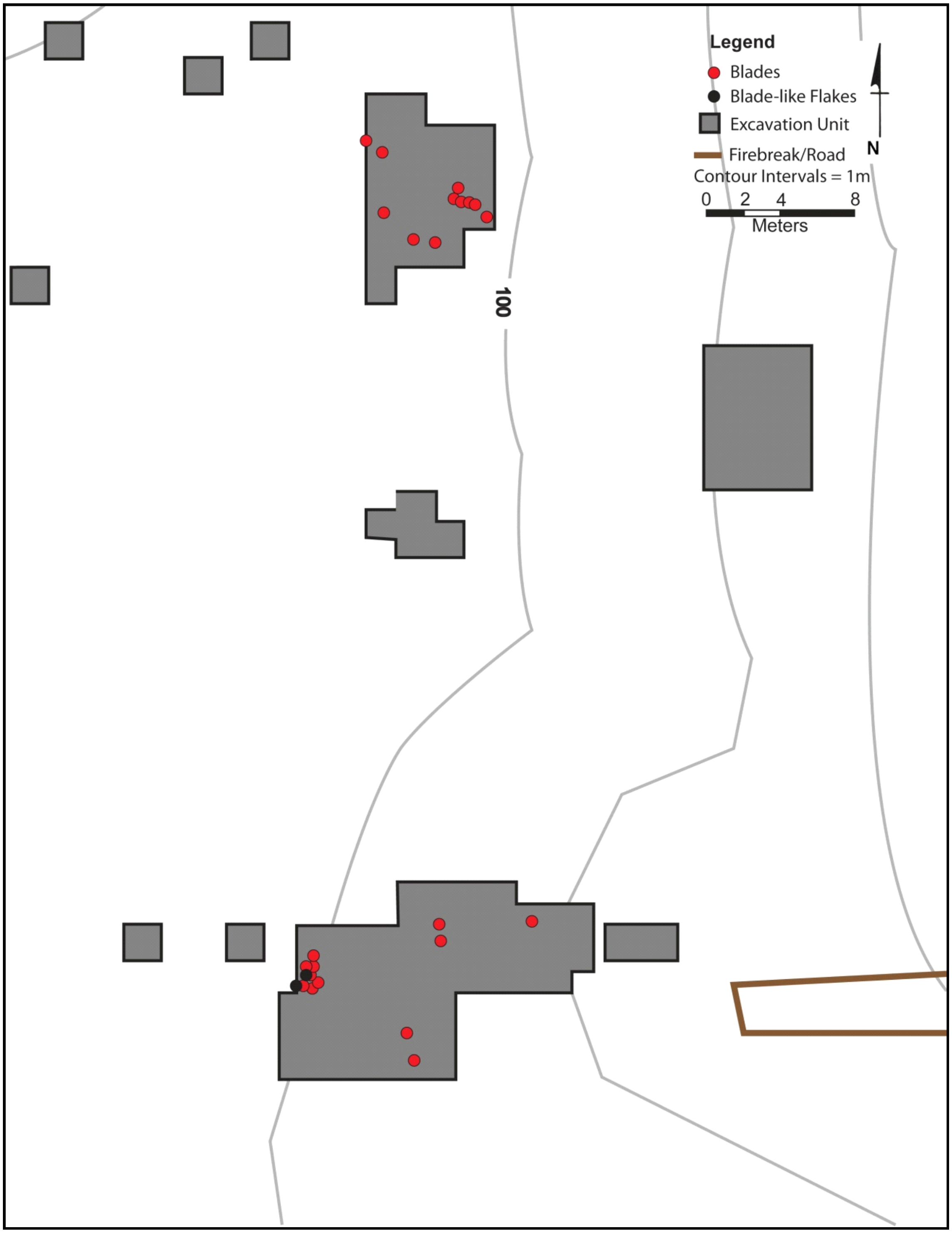


Figure VII-4.
The distribution of piece plotted blades and blade like flakes from the Alluvial Terrace at the Topper Site. (Image courtesy of D. Shane Miller. Adapted by Jessica Beltman).

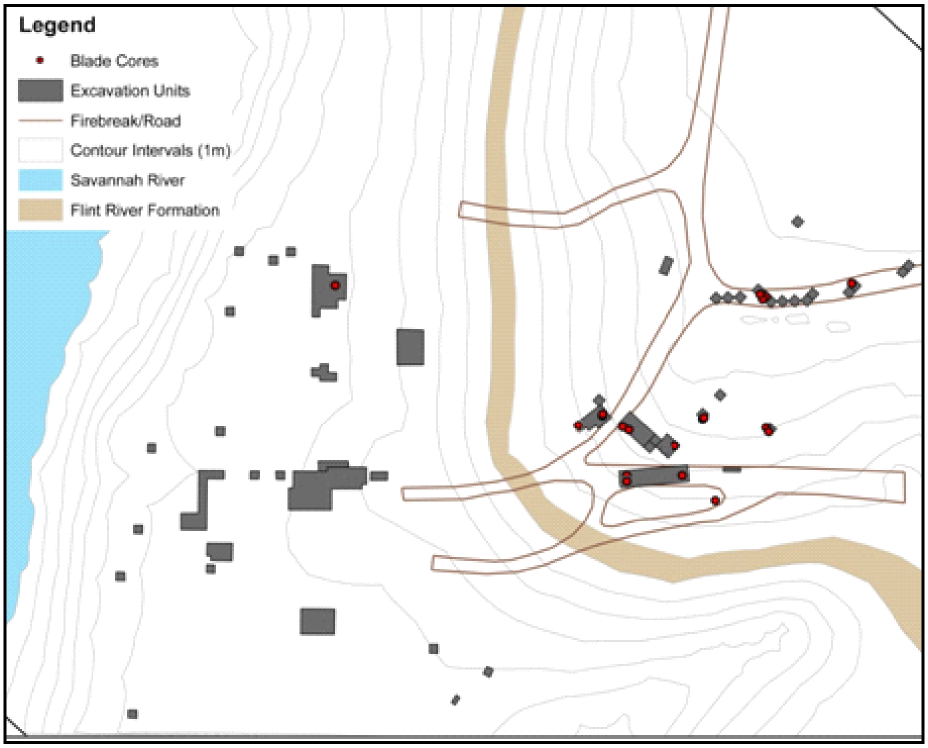


Figure VII-5. The spatial distribution of blade cores at Topper (Image courtesy of D. Shane Miller).

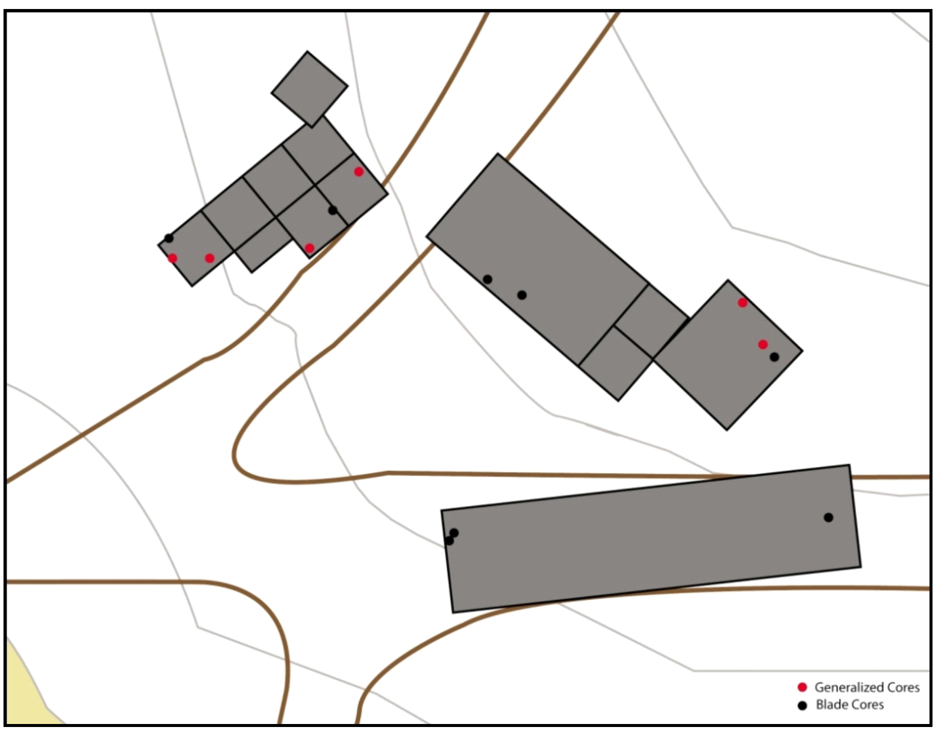
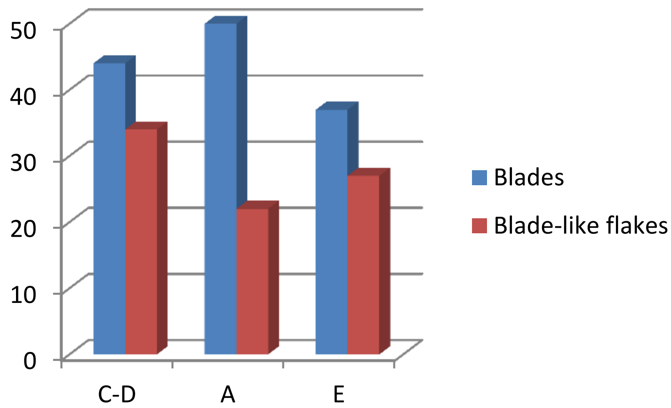
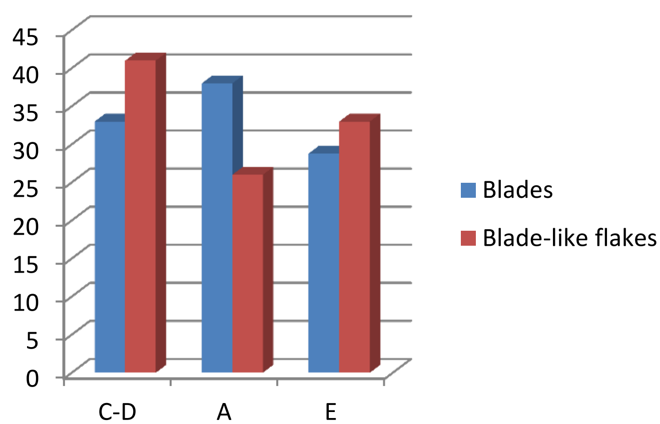


Figure VII-6.
The distribution of blade cores and generalized cores from the sample examined from the hillside (Areas A, B, and C) at Topper. (Image courtesy of D. Shane Miller, adapted by Jessica Beltman).



A



B

Figure VII-7.
Bar graphs comparing the density of all blades and blade-like flakes (including non piece plotted artifacts) from specific excavation areas across the site. A shows the number of blades by area, while B compares the distribution as a percentage.

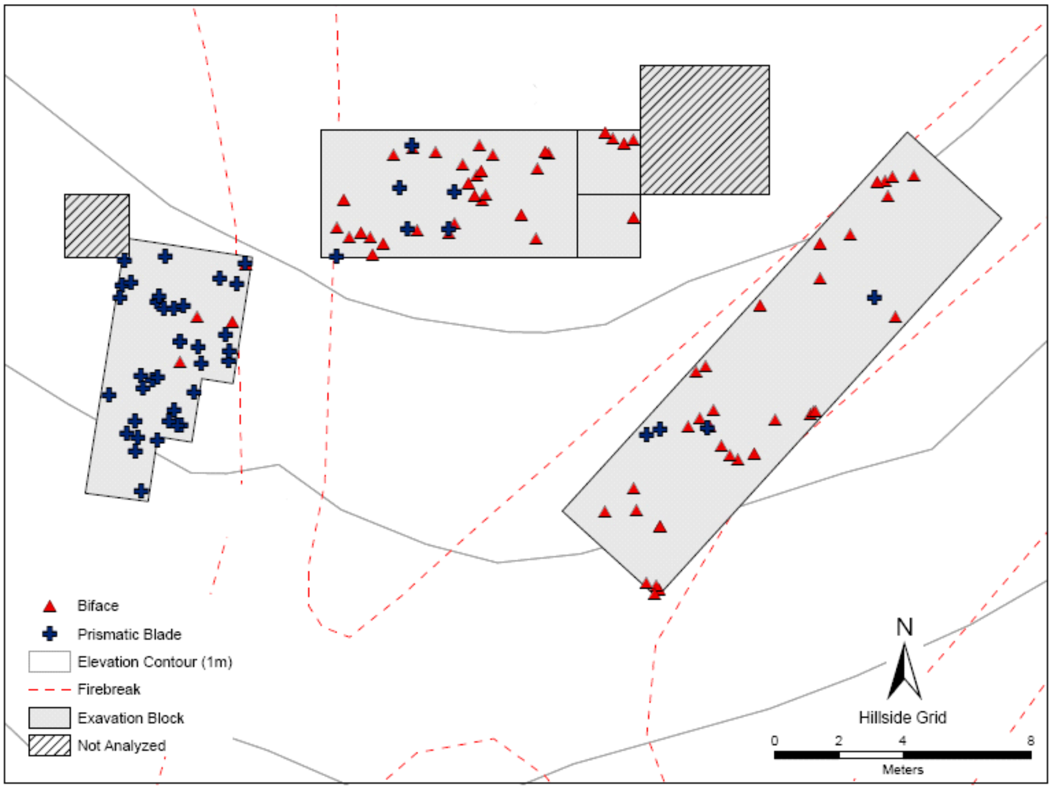


Figure VII-8. The Spatial Distribution of blades and bifaces from area A left, area B right, and area C top. (Map courtesy of D. Shane Miller).

Biography

Douglas Sain is a doctoral student at the University of Tennessee, specializing in lithic technology and Paleoindian Archaeology. Douglas received his Master's degree in Anthropology from Eastern New Mexico University, and his Bachelor of Science degree from Appalachian State University. His thesis research documents Clovis blade technology and Technological organization at the Topper Site (38AL23) in Allendale County South Carolina. He has worked as a site supervisor at Topper since 2005, and with Dr Al Goodyear, has published on Clovis blade technology in the Central Savannah River Valley of South Carolina. His dissertation research focuses on Paleoindian lithic technology and the pre-Clovis component at the Topper Site.